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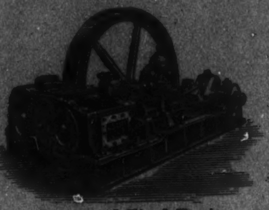

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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XVI.—NO. 371.

ELECTRIC LIGHTING FOR RAILWAY CARRIAGES.

IN the ELECTRICAL REVIEW for January 12th of last year we commented at some length upon two systems which had been brought forward for providing our railway carriages with an effective light by the application of electricity. One method was that of employing a dynamo and driving engine combined and carried by the locomotive, the boiler of the latter supplying steam; the other consisted of a combination of dynamo and accumulators, the generator of the electric current being driven by means of belting from the axle of part of the rolling stock.

We stated at the time that anything electrical in connection with railway operations should be of the most simple nature, and that we should therefore be inclined to place most confidence in that system which apparently offered the least chance of failure. It is therefore not a little gratifying to find our views generally supported by such well-known men as Messrs. W. H. Massey, Gisbert Kapp and R. E. Crompton, although we must, in justice to the advocates of the accumulator system, admit that Messrs. Stroudley and Houghton have been most successful in the application of the dynamo-accumulator combination. In the method first mentioned the objection that the lights are extinguished whenever it may be necessary to uncouple the locomotive engine which carries the dynamo was naturally raised. Mr. Massey meets this by remarking that such a contingency ought not to weigh with those who know from experience that it makes little or no difference in well-lighted stations whether the carriage lamps are lighted or not. This argument is ingenious, but fails from the fact that we do not yet possess the well-lighted stations which would diffuse sufficient illumination through any carriages there standing. Mr. Kapp goes further and makes a practical suggestion for meeting the difficulty. This gentleman, in the correspondence columns of a contemporary, says there is no reason whatever why the lights should be extinguished for a single instant, although the train might be left standing without its locomotive for any length of time. All that would be required would be a dynamo fixed in the station where the trains are made up and the provision at suitable places along the platforms of flexible twin cables in connection with the main leads from the dynamo. Some of the coaches in each train, or preferably all the coaches, should be provided with terminals connected to the main leads throughout the train, which would fit a clip attached to the end of each pair of flexibles. To prevent reversal of polarity the clip should be so arranged that it would only go on one way, and the flexibles might be stowed away under the edge of the platform in the same way as are the India rubber gas pipes in Broad Street and other stations.

Immediately a train comes in the nearest flexible would be clipped on to any of the terminals within reach, and for the time being the train would be lighted jointly from the dynamo on the locomotive and from that fixed in the station. After detaching the locomotive, the station dynamo would continue to light the train until a new locomotive was coupled on. The dynamo in the station, with its engine, leads, flexibles and clips would be far cheaper, thinks Mr. Kapp, than a set of accumulators for every train, and would also have the additional advantage of serving at the same time for the permanent lighting of the station. Mr. Crompton adds:—"I would call attention to the self-evident fact that electric lighting mechanism does not differ from other mechanism, in that trustworthiness and efficiency go hand in hand with simplicity and few parts. Again, although no prominent mention has hitherto been made of the fact, there is absolutely no comparison between the cost of direct running and of the van dynamo-accumulator system, the cost of the latter, whether for first cost or for maintenance, being quite double that of the former."

It appears, then, that the three gentlemen whose opinions we have quoted are all in favour of electric lighting being carried out without the addition of secondary batteries to the plant. The suggestion of Mr. Kapp is a novel one, but there are, we think, grave difficulties in the way of practically carrying out the scheme.

We imagine that in many instances there are stations in which trains are made up, or, at all events, where carriages are taken on and off, so unimportant in themselves as not to warrant the adoption of a dynamo and engine for permanently lighting the usual offices and platforms. There would again be considerable difficulty in preventing short circuiting or leakage from a set of flexible leads when used and stowed away in the manner of India rubber gas pipes, and the probabilities are that the station itself would frequently be left in darkness from such causes. Nevertheless Mr. Kapp's idea is one which, for special cases, we are inclined to think worthy of a trial. The great advantage possessed by the present modes of lighting railway carriages is, especially so far as oil lamps are concerned, that each carriage is independent of its neighbours. In cases of a breakdown, or of more serious disasters, this is a desideratum, the importance of which can scarcely be over estimated. Whether this will ever be accomplished by means of electric lighting remains to be seen, if so, it certainly will not be by the method of supply upon which we have just commented. Secondary batteries are being improved, and their weight, for producing a given effect, much reduced, and we can yet conceive each carriage supplied with three or four cells to work a low resistance incandescent lamp so as to render each car independent of the rest. Such a scheme would, of course, necessitate the provision of charging stations, but if tram cars are to be propelled and lighted by the means pointed out by us a fortnight ago, and Mr. Reckenzaun's recent experiments appear to point to such a happy result, what is to prevent the latter application, eventually, to railway trains?

Improvements in nearly all branches of the applications of electricity have been so rapid and important that it is rather venturesome in the present day to give decided opinions on any matter which is not already well established. We will, therefore, only add that we trust the new year will provide abundant opportunities for the fair and impartial trials of every system which promises good and lasting results.

THE ELECTROMOTIVE FORCE OF THE DANIELL CELL.

By Dr. A. VON WALTENHOFEN, Professor at the Technical High School of Vienna.

NUMBER 16 (1884) of this journal contained a memoir by A. von Ettingshausen on Clark's normal element, and on its application in standardising galvanometers.

In the introduction to the memoir in question, it is said:—"A. Wassmuth, as far back as 1870, used the electromotive force of the Daniell element (the zinc being immersed in dilute sulphuric acid 1 : 15), which he, in accordance with the statement of Von Waltenhofen, assumed to be 12·04 Jacobi-Siemens = 1·086 Volts."

Although it is the treatise of Wassmuth that is quoted, which gives the origin of the value here given for the electromotive force of Daniell's element, I think it may be useful to remark (as not everyone may refer to the original document) that A. Wassmuth, when he carried out the research in question in my laboratory at Prague, did not base it upon a mere "statement" of mine (in the ordinary sense of the word), but upon a result which I had arrived at in consequence of my own independent investigations; a result, moreover, which deviated more or less completely from all the previous determinations of earlier physicists, and occupied at that time a perfectly isolated position. Hence, it certainly would not have been selected by A. Wassmuth without a careful critical examination.

The values generally given in text-books and lectures for the electromotive force of Daniell's element, were all considerably smaller than that found by me, 12·044 in Siemens-Jacobi measures, or in Congress units

D = 1·088 volts.

Here belong, in the first place, the values often quoted at that time as resulting from the investigations of Müller and of Poggendorff, and which after recalculation from the arbitrary units employed into absolute measures (as far as existing data permit) give respectively the figures:

D = 0·971 volt (Müller).
D = 0·922 volt (Poggendorff).

They may be found calculated in Jacobi-Siemens units on p. 474 of my treatise: (*New Method of Measuring the Resistance of Galvanic Circuits.* Pogg. Annalen. Vol. 134, p. 244) along with the values deduced from the researches of Beetz, Regnault, Buff, and Bosscha.

Among these values, that given by the last-mentioned physicist enjoyed a certain preference, because it—in contradistinction to the others—was determined in absolute measure, although on Ohm's method, which, as I have shown, is open to objections even in constant circuits. His value is:

D = 1·026 volts (Bosscha)

and is therefore considerably smaller than my result. This applies also to the other values referred to above (0·936 and 0·887 [Beetz]; 1·016 [Regnault], and 1·054 [Buff]).

The difference between my result and that of the other physicists would have made me hesitate at publishing it, had I not felt sure of its accuracy, and had I not ascertained the reason of those discrepances.

Strictly speaking, only the results of Bosscha can be taken into consideration along with my own, since his determination and mine were the first absolute measurements of the electromotive force of Daniell's cell. All previous determinations of this magnitude did not admit of accurate recalculation into absolute measurements on account of their arbitrary units, which were not in all cases capable of comparison.

Bosscha's determination was effected on Ohm's method, and must, therefore, in consequence of the polarisation (which I have demonstrated even in so-called constant cells), necessarily give too low a value for the electromotive force. This source of error is evaded only by the "compensation method," and then only by the use of the second procedure suggested by Poggendorff.

My determinations of the electromotive force of Daniell's cell were the first absolute determinations made by a method free from errors, and at the same time they were the first performed with the original resistance apparatus of Siemens. They gave for the magnitude in question a higher value than all earlier determinations.

It has, however, been confirmed by the most accurate recent measurements. The value which I found in 1867,

D = 1·088,

is exactly the same as that found by H. von Ettingshausen (see his treatise above mentioned, p. 493) on comparing a Daniell element with a Clark normal element. The value

D = 1·080 (H. F. Weber)

is obtained by reducing H. F. Weber's figures 1·0954 (based on the assumption 1 Siemens unit = 0·956 ohm) to the most recent determination (1 ohm = 1·06 S. E.) 1 S. E. = 0·943 ohm. The value

D = 1·079 (Reynier)

is given also by Reynier, as Ettingshausen remarks. From the investigations of A. Wright, based upon the value of the Clark element as given by Ettingshausen, we deduce, also:

D = 1·079 (Wright).

It must be remarked that the three last-cited figures belong to elements in which the zinc cell was filled with a solution of zinc sulphate, whilst I used in my Daniell elements dilute sulphuric acid (1 : 15). It must be also remarked that Kittler found the power of a so-called normal Daniell (without diaphragm) always greater than that of an ordinary Daniell (with a diaphragm). For the latter, Kittler gives in his memoir (p. 499) an electromotive force of 0·94 to 0·92 (average 0·93), therefore less than that of his normal element (1·195 volts). For an ordinary Daniell with dilute sulphuric acid and a diaphragm this would give D = 1·111.

As to my experiments, the results of which—deviating so widely from those of earlier determinations—have been signally confirmed by the most recent investigations, I will remark that the 14 determinations which I published have been obtained not with one, but with nine different Daniell elements, the resistances of which varied from 0·38 to 4·1 S. E.

These experiments were the first of this kind made with the original resistance apparatus of Siemens and Halske. This circumstance has been pointed out by Wüllner when he characterised my determination of the electromotive force of a Daniell circuit as that affording the greatest certainty, whilst Wassmuth, in selecting the number given by me as a basis for the determination of the factor of reduction, emphasises the fact that in my measurements of the Daniell cell a method was employed which excludes the influence of polarisation.

These considerations secured acceptance for my results before they were confirmed by the measurements of others.

The still higher values (1·2 volts and upwards) which have been recently obtained by some observers I shall discuss at a future opportunity.—*Zeitschrift für Elektrotechnik.*

THE DAVIS CUT-OUT AND CONTACT CHANGER.

THE Electrical Development and Manufacturing Company, of Boston, Mass., has acquired the sole right to manufacture and sell the Davis cut-out and contact changer, recently invented, and is now prepared to fill orders from electric lighting companies and others requiring a simple, absolutely safe, and effective cut-out, circuit changer, or pole changer.

In using this cut-out for electric light circuits, it is impossible, says the New York *Electrical Review*, to form a dangerous arc, even under the severest tests, for the reason that the contact points are not moved until the switch handle has brought them under the control of powerful springs, and out of control of the operator. This being the case, when the handle is moved in either direction, the possibility of leaving the contact pieces in a dangerous position, or of drawing an arc by a slow movement of the parts, is avoided.

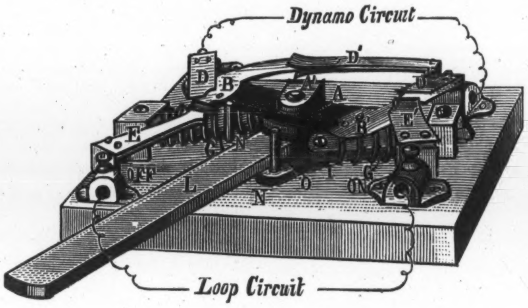


FIG. 1.

The most important feature of this switch is the embodiment of the principle above explained, but in all other respects the parts have been so arranged and constructed as to avoid all objections hitherto discovered during an extended experience with various other forms by the inventor. The contacts are all double and removed to a safe distance from any inflammable material, the contact points are well separated by air spaces, and the general construction substantial in every respect.

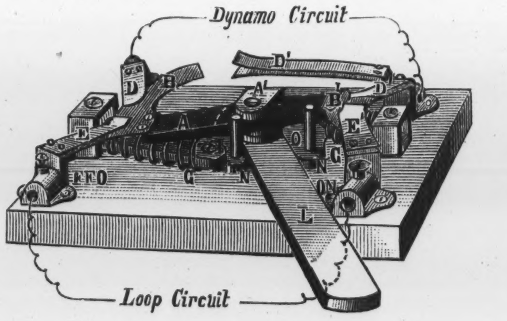


FIG. 2.

Constructed as a circuit changer for switching lamps from day to night circuit, the rapidity of movement, and its position as well as automatic character, renders the manipulation of the switch perfectly safe in the hands of an inexperienced person.

As a pole changer, the rapid automatic movement is obviously of especial advantage.

Following is a description of the construction and operation of the Davis cut-out, reference being had to the diagrams. Each cut-out is properly enclosed in a neat box, with sliding cover, not shown:

Fig. 1 represents the position of switch, with lamps cut out of circuit; the dynamo terminals, D and D', being connected by contact piece, B, and the loop terminals, E and E', being out of contact with the dynamo circuit.

Contact pieces, B and B', are mounted on the hard rubber block, A, which block is loosely pivoted upon shaft A', and may be thrown powerfully in either direction by compression springs, G, G.

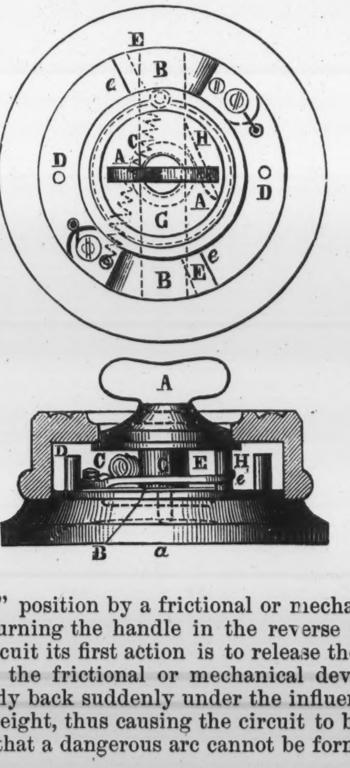
The moving ends of compression springs are electrically connected with dynamo terminals, D and D'.

To again cut off the lamps, a movement of the lever, L, in the opposite direction will bring the springs to a position of equilibrium before moving the contact pieces, and reverse the operation above described.

It will be understood that the lost motion between the lever, L, and pins, N, N, prevents any to-and-fro movement of the contact pieces by manipulating the lever, and the lost motion between the oscillating plate, O, and block, A, prevents a change of contacts until the springs have absolute control.

HOLMES'S ELECTRIC LIGHT SWITCH.

THE object of this invention is to prevent the formation of a destructive "arc," when the electric current is broken, by means of a switch or other arrangement. The inventor has designed an arrangement of switch which allows the contact piece, or a portion of it, by the influence of an independent force, such as that of a spring or weight, to move through a certain distance independently of the handle. The spring or weight is so arranged as to tend to keep the movable contact piece in the "off" position, but on turning the handle to complete circuit the contact piece is moved in opposition to the force of the spring or weight, and is kept in the "on" position by a frictional or mechanical device. On turning the handle in the reverse direction to break circuit its first action is to release the contact piece from the frictional or mechanical devices, and allow it to fly back suddenly under the influence of the spring or weight, thus causing the circuit to be broken so quickly that a dangerous arc cannot be formed.



The figures show the elevation (partly in section) and plan of a small sized apparatus. The latter consists of an outer covering or box of any suitable material, enclosing the mechanism, having a lid overlapping the disc described further on, and from the centre of which a handle, A, projects, whereby the connection can be made or broken as required. The axis of this handle is supported in a bearing, *a*, at the bottom of the box. The connecting bar or contact piece, B, swings loosely on the axis, a spring, C, keeps the bar, B, in the "off" position against stops, D, D, when not prevented by force, or when the connecting bar is not held tight in the friction catches or contacts, E, E. These contacts consist each of two flat metallic plates or jaws laid upon each other, and held together at one end by screws, their other ends, *e*, *e*, which face the contact bar, B, are somewhat wider apart, so as to admit of the bar being forced in between them and held tightly; they thus act as a frictional contact, holding the bar against the force of its spring, C, which is also in such a position as to have little power on the bar.

Above this arrangement the axis of the handle carries a disc, G, holding the contact bar, B, in place, and having a ward or flange, H (or its equivalent two pins), placed eccentrically upon its lower surface, forming a sort of crank-pin or lever, which when standing in a direction approximately parallel to the direction of the bar stands clear of the same. This ward is of such width and is so placed upon the disc that it can be rotated about 30 degrees of the circle without touching the bar, B. When, however, the handle, A, is turned, the disc, G, revolves with it, one end of the projecting flange, H, comes against the contact bar, B, and pushes it out from between the jaws, *e*, *e*, of the contacts, E, E. As soon as the bar is thus released the spring, C, draws it back until it is checked by the stops, D, D. Thus, however slowly the handle be turned, the contact bar is rapidly propelled away the instant the contact is broken. When it is desired to again make contact the handle is turned the opposite way, the opposite end of the flange, H, comes in contact with the connecting bar, B, and forces it forward and between the jaws of the contacts, E, E, against the force of its spring, C.

GORHAM'S PUPIL PHOTOMETER.*

THIS beautiful and most ingenious instrument, to which our attention was first called by Mr. Tindall, is as simple as it appears to be effective. It consists of a piece of bronzed tubing about 1·9 inches long, and 1·5 inches in diameter, with one end closed by a disc, in which are a series of pairs of minute holes pierced on radii of the circle, and drilled with absolute accuracy at distances varying from ·05 inch to ·28 inch apart. A cap with a radial slot in it so narrow as only to leave one of these pairs of holes visible at a time, rotates over the brass disc; and round the cylinder just below the edge of the cap the linear distance of each pair of holes is engraved exactly opposite to it. Our first figure represents the cap as seen when looking down on to it. The pair of holes ·10 inch apart are shown as visible through the slot. Fig. 2 exhibits the tube as seen sideways, to show how the figures are engraved upon it. The instrument seems to have been originally devised by Mr. Gorham for measuring the diameter of the pupil of the eye under the stimulus of light of varying intensities. It is used by looking through the open end of the tube (the bottom in fig. 2), when two discs of light will be seen, like a double star. The cap is turned until a pair of these discs appear which are precisely tangent, or *just* touch one another at their edges. Then may the diameter of the pupil be read off on the scale by mere inspection to ·01 in. But this is by no means the only—or, in fact, the chief—use of Dr. Gorham's instrument, inasmuch as the magnitudes of the pupil really furnish the measures of the intensities of the lights under whose influence its diameter varies. Hence it may be used as a photometer; and for this purpose we proceed as follows:—We set a Sugg's standard candle at a distance of one foot from the eye, with a white surface (such as a sheet of foolscap paper) behind it, in a room otherwise totally dark. We now take the diameter of the pupil in the way just indicated, and read it off from the scale. Leaving the photometer intact, we substitute for the candle the source of light whose intensity we wish to measure, placing a white background behind it, as in the previous case. Suppose that it is a duplex lamp which replaces our original candle. If we regard this from a distance of one foot, as before, we shall find our two discs of light, so far from touching, will be pretty widely separated, and we must slowly retire from the lamp until the circles have expanded sufficiently to become tangent again; when, of course, the pupil will have regained its original dimensions, from the light falling upon it being of identical intensity with that of the candle. It only remains to measure the distance of the lamp from the eye in feet and decimals of a foot to find its illuminating power, which obviously will vary as the square of the distance, *i.e.*, if we have to retire to a distance of four feet the lamp must give the light of 16 candles, and so on. In a foot-note to Mr. Tindall's letter a doubt was expressed as to the efficiency of Dr. Gorham's invention as a *quantitative* light-measurer. In connection with this we may mention that, as a preliminary to penning this article, we have been experimenting with a candle and a small reading-lamp, the relative intensities of whose lights we measured in succession by Rumford's method and by the instrument we are describing. By the former mode of measurement we found that the lamp gave 7·1113 times the light of the candle; by the new photometer it came out 7·111! It would perhaps be idle to contend that no element of "fluke" entered into this extraordinary coincidence; but it may serve to show with what minute accuracy the relative intensities of various illuminating agents can be measured by this most simple apparatus. The incipient user of it will find it politic to keep his unused eye open; as, if it be closed, and then opened while the photometer is being employed, the stimulus of the light on the freshly-exposed pupil will cause the one viewing the hole itself to contract sympathetically, and so derange the measurement.

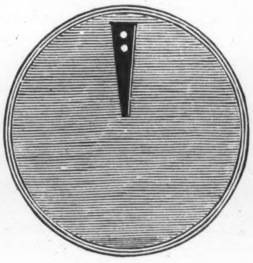


FIG. 1.

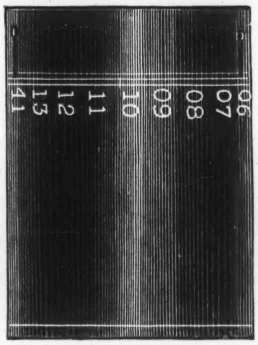


FIG. 2.

THE "SUN" LAMP.

[A COMMUNICATION.]

SINCE the time when the "Sun" Lamp was first brought before the notice of the readers of the ELECTRICAL REVIEW it has undergone many improvements, and it is the last model that it is now proposed to discuss.

The model exhibited in the Paris Electrical Exhibition consisted of a refractory block in seven parts, somewhat expensive to replace. Moreover, the lighting was effected by a wick, and the lamp could not be relighted automatically. Some experiments made with regard to this point gave rise to models too complicated to be practical in this type of lamp. Besides, a different model was required for each length of arc, for each different inclination of the lamp.

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* *Knowledge.*

These defects disappeared in the model with horizontal carbons, constructed in February, 1882, by M. Clerc. In this, the only part that required changing was a block of marble, 3, 4, and 5 centimetres. This block was cut with a drill and not with a file, as in the former model. Only the shape varied for each length of arc, and the lamp could be inclined to any position. Instead of descending by their weight, the carbons were pushed by springs in guiding tubes, which was a surer method. M. Bureau soon showed that this block of marble might be enclosed in a case of cast-iron without enveloping it in refractory material, and thus a more industrial appearance would be given to the lamp. In April, 1882, M. Clerc conceived the idea of enabling the apparatus to be relighted at will, either by hand or automatically, by making one of the carbons hollow in the centre, and placing a small carbon in the hole, which, being pushed forward, would establish the arc, and in sliding back would light the lamp. This model was worked in June, 1882, at the Royal Exchange, London. (See the ELECTRICAL REVIEW, July 1st, 1882.)

Once having obtained a practical method of relighting, MM. Clerc and Bureau next turned their attention to finding a means of successfully placing many lamps in series, and it was for this purpose that they constructed the automatic switch which now accompanies every Sun Lamp.

With this switch there is always a closed circuit, whatever may be the condition of the lamps. It leaves a slight resistance in the place of the lamp, and this resistance is only cut out when the lamp is ready to be lighted.

Its action is as follows:—A small coil moves a cylinder of soft iron, bearing a fork which serves to connect two vessels containing mercury. A resistance is placed in derivation on the two terminals that conduct the current to the lamp, and the fork, by connecting the two vessels of mercury, completes the circuit of this resistance. The lamp current goes from one of the terminals to the small coil above-mentioned, passes through it into one of the carbons, and then from the other carbon to the other terminal of the lamp. When the current is introduced, as the two carbons of the lamp are not connected, it passes entirely through the resistance. When the two carbons are connected by the small movable one, the current has two paths:—1. Through the resistance. 2. Through the small coil, the first carbon, the small carbon, and the second carbon. The resistance required in order to allow sufficient current passing into the small coil to raise the soft iron core and the fork, and thus break the circuit of the resistance, is about 2 ohms. Under these conditions the whole of the current passes through the lamp, which is then lighted by the recoil of the small carbon. We see that with this switch the circuit can never be broken, and that many lamps can be placed in circuit without fear of any mishap. At the Health Exhibition, last year, the lamps were burning 12 and 13 in circuit.

With this addition the lamp worked by hand was the more extensively used, for the automatic model still had three serious defects.

The coil working the small carbon required a considerable force, and made a disagreeable noise; also it lighted the lamp too suddenly, and the lighting was difficult owing to the successive extinctions and relightings of all the lamps in the circuit.

M. Clerc remarked in the first automatic lamps that the coil moving the small carbon required an excessive force 20 to 25 per cent. of that of the lamp. He ascertained that the resistance of the coils, which was in wire 0·2 ohms, rose to 3 ohms when working with an alternating current. (This fact was so little suspected, that some engineers of the Sun Lamp had combined a lamp of the old type with an automatic relighting apparatus. This model, which gave a very bad light and was worked with difficulty, had, it was said, the advantage of diminishing the force required.) Calling public attention to this fact, and to the error, M. Clerc also indicated the means of obviating two of the inconveniences of the automatic lamp. For this purpose he employed the coil of the relighting apparatus as the resistance of the safeguard switch, and made it act so as to bring the small carbon into contact. This contact was hardly effected when the safeguard cut off the circuit of that coil, and the little carbon recoiled. So that the coil actually performed the work of the hand in the hand lamp, for the coil acted only to light. This coil was then made extra strong for complete security, and the automatic lamp became silent.

Since that time, March 1883, the automatic lamp has been regularly used. Simultaneously with this solution others were proposed. We shall speak of that of Messrs. Street and Maquaire, which followed.

In this system the coils form a special circuit fed by a derivation of the generator. A hand rheostat is placed on the circuit of the coils. By giving more or less resistance through the rheostat, more or less force is given to the coils, and the small carbon is moved more or less at will.

This system requires one wire more, and does not allow of each lamp being lighted on the spot and at will; in this lies its inferiority to the preceding one, which, moreover, these gentlemen have adopted. But in special cases, at the theatre, for example, in order to represent day or night gradually approaching, this system would be perfect.

There still remained in the automatic lamp the inconvenience of too sudden lighting. The Sun Lamp is, it is well known, a lamp with the distance between the carbons fixed, the carbons each abutting on to one side of the marble. At the commencement, when the lamp is cold, the resistance is about twice as high as when it is well lighted. As we cannot change the force of the machine, it is necessary to light the lamp slowly, in order that the lamp may have time to heat in proportion as the arc increases by the recoil of the small carbon.

For this purpose M. Bureau applied air and oil moderators, and M. Clerc a mercury moderator; but by none of these was the lighting effected slowly enough. In September, 1883, M. Clerc thought of regulating the recoil, so that the small carbon could only move back a certain regulated distance, so as to render the resistance of the lamp when cold equal to that of the lamp when lighted; the small carbon is thus slowly consumed, and the lighting is effected in absolute security, whatever the number of lamps lighted at once.

Under these conditions, whether the lighting is effected by hand or automatically, it can no longer be too sudden, whatever may be the nature of the machine, and the lighting becomes absolutely reliable.

It is in this improved form that Mr. Clerc has constructed his model in London. With the immense force of the motive coil which raises 1,500 gr., we have perfect safety. A weight of 600 gr. pushes forward the little carbon. The solenoid of soft iron weighs 1,500 gr. and draws back the little carbon. A ratchet, moved by the solenoid, releases a toothed wheel when the solenoid rises and, the weight advancing, the small carbon acts. As soon as the contact is established the soft iron core falls back, the ratchet catches the toothed wheel and draws back the small carbon. A regulating screw limits the course of the soft iron core, and the small carbon only recoils to a certain distance.

The person attending to the lamp during the day can move the soft iron core with a rod as the current does at the lighting. He should see the little carbon move, and assure himself that the lamp will work, so that he can thus be made responsible for it.

But if, through omission, the little carbon has been left too short, or should happen to slip, the current permanently traversing the lighting coil would burn it. M. Clerc has rendered any accident of this nature impossible by doubling its safeguard, so that if the lamp does not light, it is short-circuited.

To effect this, when the coil gets heated it expands a spring of two metals, which makes contact with a regulating screw closing the second bobbin of the safeguard—the soft iron of this coil rises and by a metallic cone closes a circuit which passes through the second coil only and this contact of the cone so that the lamp is itself suppressed. Thus the lamp sustains no injury even in the case of neglect on the part of the attendant, a contingency that should be provided for in every good lamp.

After these main improvements which render the lamp very convenient and perfectly safe, we will examine the minor ones. In the first place, there is the mode of insulation to be adopted. Until January, 1884, the only mode of insulation employed was to place mica round the joining screws, a tube in the centre, and two small round shields at the extremities. With this method it is impossible to verify the nature of the work or the effectiveness of the insulation, and accidents are of frequent occurrence. In January, 1884, M. Clerc thought of using sheets of mica as a solid insulator and of supporting, on the extremities of this sheet of mica of four or five millimetres, the parts to be insulated. Mica is sufficiently stiff for this work. The parts are then fixed to the mica. Care must be taken that the part fixed to one side of the mica does not touch that fixing the mica to the other side. It can easily be seen whether this is the case and complete insulation will then be obtained. It is by this system that we arrive at a case for the block of marble, ensuring absolute security.

The lamp is placed in a circular shade 40 centimetres in diameter, such as has been used since the invention of the horizontal sun lamp by M. Clerc in 1882. Two half globes give the lamp the form of a round globe, and if the globes are of opal the lamp will give light in all directions, above as well as below. Two lateral handles contain the lighting coil and the weights. A top placed above the handle receives the double safeguard switch. Some fretwork ornament hides the switch and embellishes the edge of the hemispheres. So much for the exterior of the lamp, which may be inclined at any angle according to the direction of the lighting, and can also be inverted to light up the ceiling. The case consists of four insulated parts. The two extremities support the tubes which hold the carbons. These latter are 20 millimetres in diameter and consume at the rate of 2½ millimetres per hour. Each carbon has behind it a copper cylinder of the same diameter and 30 millimetres long. It is on these cylinders (which push the carbons forward) that the levers act. These levers are mounted on pivots in order that the movement may be very gentle. A spring causes them to turn. At their extremity is a thick movable hook that acts upon the cylinders and thus the carbons advance. Two cross-pieces insulated from the circle as above and each bearing a lever support the box by the two tubes and each receives one wire of the circuit.

When a carbon is consumed, the lever that pushes it comes against a rod connected with the other cross-piece and the lamp is thus short-circuited.

The inside of the case can revolve round the tubes to give light in any required direction where it is not possible to incline the lamp. The case contains a block of marble, 4 centimetres long, 3 high, and 3 wide. This reduced block offers absolute security, and its cost is very little. The carbons also cost very little. With this reduced block we shall arrive at an unexampled price per hour of the lamp. Up to the present the block of marble has been cut into a cone underneath, and the light projected in the form of a cone. When the illuminated area was not very high the useful effect was thus limited.

In March, 1884, M. Clerc planned a shape which increases the useful effect 40 per cent. more in almost every case. To do this, instead of using a cone, he pierces in the marble a horizontal hole, half cylindrical, and having its generators perpendicular to the carbons. The hole is 22 millimetres wide and 11 high. It is pierced with a drill, two marbles being placed side by side, so that instead of a cone the lighting is horizontal for three-fifths of the circumference, the remaining two-fifths being in the direction of the cone. As there is nearly always one particular direction required for the lighting, this arrangement effects considerable saving, and in workshops two pieces of marble cut in this manner give the useful effect of three in the form of a cone.

In the Sun Lamp, as in all lamps, the voltaic arc changes its position on the carbon. Taking into consideration its dimensions and the small current strength employed, the carbons of the lamp give comparatively little light, and the point where the arc is produced is comparatively brilliant. This change of position is little noticeable in the horizontal lamp, for it is only when the arc is produced in the upper part of the carbons that it can be observed. It was desirable to give to the light absolute fixity, especially for lamps lighting ceilings, and this mode of lighting will become more and more general on account of the extraordinary softness of the light. In fact, in this case, the light itself is no longer seen, and the lamp will generally be disguised by an artistic ornament. The ceiling only gives the light, and upon the ceiling the slightest shifting of the arc is observed. The softness of the light, the absence of shade, which enables one to read or work in any part of the illuminated area, should render this method of lighting with the inverted sun lamp exceedingly popular. In industrial circles this mode of lighting will also frequently be employed in cases where it is necessary to avoid shadows, and several factories have already adopted it.

In order to arrive at the absolute fixity necessary with this mode of lighting and desirable with the ordinary lighting, M. Clerc employed carbons not wholly round but flat at the top. This flat part of 15 millimetres reduces the vertical diameter of 5 millimetres. With these semi-flat carbons the arc is never produced sufficiently high for the change of position to be observed; the light is everywhere perfectly steady, and there is no longer any trace of violet rays. Moreover, these semi-flat carbons have the advantage of never penetrating the marble even slightly as the round carbons do. The consumption is 3 millimetres per hour instead of 2½, which difference may be disregarded.

In its present form the Sun Lamp may be said to be complete, and absolutely reliable even as an automatic lamp.

(*To be continued.*)

THE WAVE THEORY OF LIGHT.

By SIR WILLIAM THOMSON, F.R.S., LL.D., &c.

(A Lecture delivered at the Academy of Music, Philadelphia, under the auspices of the Franklin Institute, Sept. 29th, 1884.)

MR. WILLIAM P. TATHAM, President of the Franklin Institute, introduced the lecturer, who spoke as follows:—

Sir WILLIAM THOMSON: Mr. President, ladies and gentlemen: The subject upon which I am to speak to you this evening is happily for me not new in Philadelphia. The beautiful lectures on light which were given several years ago by President Morton, of the Stevens Institute, and the succession of lectures on the same subject so admirably illustrated by Prof. Tyndall, which many now present have heard, have fully prepared you for anything I can tell you this evening in respect to the wave theory of light.

It is indeed my humble part to bring before you some mathematical and dynamical details of this great theory. I cannot have the pleasure of illustrating them to you by anything comparable with the splendid and instructive experiments which many of you have already seen. It is satisfactory to me to know that so many of you, now present, are so thoroughly prepared to understand anything I can say, that those who have seen the experiments will not feel their absence at this time. At the same time I wish to make them intelligible to those who have not had the advantages to be gained by a systematic course of lectures. I must say in the first place, without further preface, as time is short and the subject is long, simply that sound and light are both due to vibrations propagated in the manner of waves; and I shall endeavour in the first place to define the manner of propagation and mode of motion that constitute those two subjects of our senses, the sense of sound and the sense of light.

Each is due to vibrations. The vibrations of light differ widely from the vibrations of sound. Something that I can tell you more easily than anything in the way of dynamics or mathematics respecting the two classes of vibrations is, that there is a great difference in the frequency of the vibrations of light when compared with the frequency of the vibrations of sound. The term "frequency" applied to vibrations is a convenient term, applied by Lord Rayleigh in his book on sound to a definite number of full vibrations of a vibrating body per unit of time. Consider, then, in respect to sound, the frequency of the vibrations of notes, which you all know in music represented by letters, and by the syllables for singing, the do, re, mi, &c. The notes of the modern scale correspond to different frequencies of vibrations. A certain note and the octave above it correspond to a certain number of vibrations per second and double that number.

I may explain in the first place conveniently the note called "C"; I mean the middle "C"; I believe it is the C of the tenor voice, that most nearly approaches the tones used in speaking. That note corresponds to two hundred and fifty-six full vibrations per second, two hundred and fifty-six times to and fro per second of time.

Think of one vibration per second of time. The seconds pendulum of the clock performs one vibration in two seconds, or a half vibration in one direction per second. Take a ten-inch pendulum of a drawing-room clock, which vibrates twice as fast as the pendulum of an ordinary eight-day clock, and it gives a vibration of one per second, a full period of one per second to and fro. Now think of three vibrations per second. I can move my hand three times per second easily, and by a violent effort I can move it to and fro five times per second. With four times as great force, if I could apply it, I could move it twice five times per second.

Let us think, then, of an exceedingly muscular arm that would cause it to vibrate ten times per second, that is, ten times to the left and ten times to the right. Think of twice ten times, that is, twenty times per second, which would require four times as much force; three times ten, or thirty times a second, would require nine times as much force. If a person were nine times as strong as the most muscular arm can be, he could vibrate his hand to and fro thirty times per second, and without any other musical instrument could make a musical note by the movement of his hand which would correspond to one of the pedal notes of an organ.

If you want to know the length of a pedal pipe, you can calculate it in this way. There are some numbers you must remember, and one of them is this. You, in this country, are subjected to the British insularity in weights and measures; you use the foot and inch and yard. I am obliged to use that system, but I apologise to you for doing so, because it is so inconvenient, and I hope all Americans will do everything in their power to introduce the French metrical system. I hope the evil action performed by an English minister, whose name I need not mention, because I do not wish to throw obloquy on any one, may be remedied. He abrogated a useful rule, which for a short time was followed, and which I hope will soon be again enjoined, that the French metrical system be taught in all our national schools. I do not know how it is in America. The school system seems to be very admirable, and I hope the teaching of the metrical system will not be let slip in the American schools any more than the use of the globes.

I say this seriously. I do not think any one knows how seriously I speak of it. I look upon our English system as a wickedly brain-destroying piece of bondage under which we suffer. The reason why we continue to use it is the imaginary difficulty of making a change and nothing else; but I do not think in America that any such difficulty should stand in the way of adopting so splendidly useful a reform.

I know the velocity of sound in feet per second. If I remember rightly, it is 1,089 feet per second in dry air at the freezing point, and 1,115 feet per second in air of what we call moderate temperature, 59 or 60 degrees—(I do not know whether that temperature is ever attained in Philadelphia or not; I have had no experience of it, but people tell me it is sometimes 59 or 60 degrees in Philadelphia, and I believe them)—in round numbers let us call it 1,000 feet per second. Sometimes we call it a thousand musical feet per second, it saves trouble in calculating the lengths of organ pipes; the time of vibration in an organ pipe is the time it takes a vibration to run from one end to the other and back. In an organ pipe 500 feet long the period would be one per second; in an organ pipe ten feet long the period would be 50 per second; in an organ pipe twenty feet long the period would be 25 per second at the same rate. Thus 25 per second, and 50 per second of frequencies correspond to the periods of organ pipes of 20 feet and 10 feet.

The period of vibration of an organ pipe, open at both ends, is approximately the time it takes sound to travel from one end to the other and back. You remember that the velocity in dry air in a pipe 10 feet long is a little more than 50 periods per second; going up to 256 periods per second, the vibrations correspond to those of a pipe two feet long. Let us take 512 periods per second; that corresponds to a pipe about a foot long. In a flute, open at both ends, the holes are so arranged that the length of the sound-wave is about one foot, for one of the chief "open notes." Higher musical notes correspond to greater and greater frequency of vibration, viz., 1,000, 2,000, 4,000 vibrations per second; 4,000 vibrations per second correspond to a piccolo flute of exceedingly small length; it would be but one and a-half inches long. Think of a note from a little dog-call, or other whistle, one and a-half inches long, open at both ends, or from a little key having a tube three-quarters of an inch long, closed at one end; you will then have 4,000 vibrations per second.

A wave length of sound is the distance traversed in the period of vibration. I will illustrate what the vibrations of sound are by this condensation travelling along our picture on the screen. Alternate condensations and rarefactions of the air are made continuously by a sounding body. When I pass my hand vigorously in one direction, the air before it becomes dense, and the air on the other side becomes rarified. When I move it in the other direction these things become reversed; there is a spreading out of condensation from the place where my hand moves in one direction and then in the reverse. Each condensation is succeeded by a rarefaction. Rarefaction succeeds condensation at an interval of one-half what we call "wave lengths." Condensation succeeds condensation at the full interval of what we call wave lengths.

We have here these luminous particles on this scale,* representing portions of the air close together, dense; a little higher up, portions of air less dense. I now slowly turn the handle of the apparatus in the lantern, and you see the luminous sectors showing condensation travelling slowly upwards on the screen; now you have another condensation; making one wave length.

This picture or chart represents a wave length of four feet. It represents a wave of sound four feet long. The fourth part of a thousand is 250. What we see now of the actual scale represents the lower note C of the tenor voice. The air from the mouth of a singer is alternately condensed and rarefied just as you see here.

But that process shoots forward at the rate of 1,000 feet per second; the exact period of the motion is 256 vibrations per second for the actual case before you. Follow one particle of the air forming part of a sound wave, as represented by these moving spots of light on the screen; now it goes down, then another portion goes down rapidly; now it stops going down; now it begins to go up; now it goes down and up again.

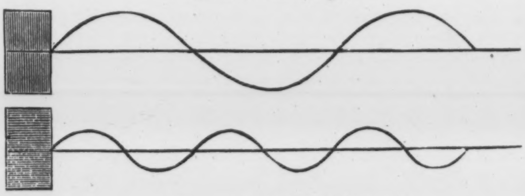
As the maximum of condensation is approached it is going up with diminishing maximum velocity. The maximum of rarefaction has now reached it, and the particle stops going up and begins to move down. When it is of mean density the particles are moving with maximum velocity, one way or the other. You can easily follow these motions, and you will see that each particle moves to and fro, and the thing that we call *condensation* travels along.

I shall show the distinction between these vibrations and the vibrations of light. Here is the fixed appearance of the particles when displaced but not in motion. You can imagine particles of something, the thing whose motion constitutes light. This thing we call the luminiferous ether. That is the only substance we are confident of in dynamics. One thing we are sure of, and that is the reality and substantiality of the luminiferous ether. This instrument is merely a method of giving motion to a diagram designed for the purpose of illustrating wave motion of light. I will show you the same thing in a fixed diagram, but this arrangement shows the mode of motion.

Now follow the motion of each particle. This represents a particle of the luminiferous ether, moving at the greatest speed when it is at the middle position.

You see the two modes of vibration,† sound and light now moving together. The travelling of the wave of condensation and rarefaction, and the travelling of the wave of transverse displacement. Note the direction of propagation. Here it is from your left to your right, as you look at it. Look at the motion when made faster. We have now the direction reversed. The propagation of the wave is from right to left, again the propagation of the wave is from left to right; each particle moves perpendicularly to the line of propagation.

Waves of Red Light.



Waves of Violet Light.

FIG. 1.

I have given you an illustration of the vibration of sound waves, but I must tell you that the movement illustrating the condensation and rarefaction represented in that moving diagram are necessarily very much exaggerated, to let the motion be perceptible, whereas the greatest condensation in actual sound motion is not more than one or two per cent. or a small fraction of a per cent. Except that the amount of condensation was exaggerated in the diagram for sound, you have a correct representation of what actually takes place in the low note C.

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* Alluding to a moving diagram of wave motion of sound produced by a working slide for lantern projection.

† Showing two moving diagrams, simultaneously, on the screen, one depicting a wave motion of light, the other a sound vibration.

On the other hand, in the moving diagram representing light waves what had we? We had a great exaggeration of the inclination of the line of particles. You must first imagine a line of particles in a straight line, and then you must imagine them disturbed into a wave curve, the shape of the curve corresponding to the disturbance. Having seen what the propagation of the wave is, look at this diagram and then look at that one. This, in light, corresponds to the different sounds I spoke of at first. The wave length of light is the distance from crest to crest of the wave, or from hollow to hollow. I speak of crests and hollows, because we have a diagram of ups and downs as the diagram is placed.

Here, then you have a wave length.* In this lower diagram you have the wave length of violet light. It is but one-half the length of the upper wave of red light; the period of vibration is but half as long. Now, on an enormous scale, exaggerated not only as to slope, but immensely magnified as to wave length, we have an illustration of the waves of light. The drawing marked "red" corresponds to red light, and this lower diagram corresponds to violet light. The upper curve really corresponds to something a little below the red ray of light in the spectrum, and the lower curve to something beyond the violet light. The variation in length between the most extreme rays is in the proportion of four and a-half of red to eight of the violet, instead of four and eight; the red waves are nearly as one to two of the violet.

To make a comparison between the number of vibrations for each wave of sound and the number of vibrations constituting light waves, I may say that 30 vibrations per second is about the smallest number which will produce a musical sound; 50 per second gives one of the grave pedal notes of an organ, 100 or 200 per second give the low notes of the bass voice, higher notes with 250 per second, 300 per second, 1,000, 4,000, up to 8,000 per second give about the shrillest notes audible to the human ear.

Instead of the numbers which we have, say in the most commonly used part of the musical scale, *i.e.*, from 200 or 300 to 600 or 700 per second, we have millions and millions of vibrations per second in light waves; that is to say, 400 million million per second, instead of 400 per second. That number of vibrations is performed when we have red light produced.

An exhibition of red light travelling through space from the remotest star is due to the propagation by waves or vibrations, in which each individual particle of the transmitting medium vibrates to and fro 400 million million times in a second.

Some people say they cannot understand a million million. Those people cannot understand that twice two makes four. That is the way I put it to people who talk to me about the incomprehensibility of such large numbers. I say *finitude* is incomprehensible, the infinite in the universe *is* comprehensible. Now apply a little logic to this. Is the negation of infinitude incomprehensible? What would you think of a universe in which you could travel one, ten, or a thousand miles, or even to California, and then find it come to an end? Can you suppose an end of matter, or an end of space? The idea is incomprehensible. Even if you were to go millions and millions of miles the idea of coming to an end is incomprehensible.

You can understand one thousand per second as easily as you can understand one per second. You can go from one to ten, and ten times ten and then to a thousand without taxing your understanding, and then you can go on to a thousand million and a million million. You can all understand it.

Now 400 million million vibrations per second is the kind of thing that exists as a factor in the illumination by red light. Violet light, after what we have seen and have illustrated by that curve, I need not tell you corresponds to vibrations of 800 million million per second. There are recognisable qualities of light caused by vibrations of much greater frequency and much less frequency than this. You may imagine vibrations having about twice the frequency of violet light and one-fifteenth the frequency of red light and still you do not pass the limit of the range of continuous phenomena only a part of which constitutes *visible* light.

Everybody knows the "photographer's light," and has heard of *invisible* light producing visible effects upon the chemically prepared plate in the camera. Speaking in round numbers, I may say that, in going up to about twice the frequency I have mentioned for violet light you have gone to the extreme end of the range of known light of the highest rates of vibration; I mean to say that you have reached the greatest frequency that has yet been observed.

When you go below visible red light what have you? We have something we do not see with the eye, something that the ordinary photographer does not bring out on his photographically sensitive plates. It is light, but we do not see it. It is something so closely continuous with light visible, that we may define it by the name of invisible light. It is commonly called radiant heat; invisible radiant heat. Perhaps, in this thorny path of logic, with hard words flying in our faces, the least troublesome way of speaking of it is to call it radiant heat. The heat effect you experience when you go near a bright, hot coal fire, or a hot steam boiler; or when you go near, but not over, a set of hot water pipes used for heating a house; the thing we perceive in our face and hands when we go near a boiling pot and hold the hand on a level with it, is radiant heat; the heat of the hands and face caused by a hot fire, or a hot kettle when held under the kettle, is also radiant heat.

You might readily make the experiment with an earthen teapot; it radiates heat better than polished silver. Hold your hands below and you perceive a sense of heat; above the teapot you get more heat; either way you perceive heat. If held over the teapot you readily understand that there is a little current of air rising. If you put your hand under the teapot you get cold air; the upper side of your hand is heated by radiation while the lower side is fanned and is actually cooled by virtue of the heated kettle above it.

That perception by the sense of heat, is the perception of something actually continuous with light. We have knowledge of rays of radiant heat perceptible down to (in round numbers) about four times the wave length, or one fourth the period of visible, or red light. Let us take red light at 400 million million vibrations per second; then the lowest radiant heat, as yet investigated, is about 100 million million per second in the way of frequency of vibration.

I had hoped to be able to give you a lower figure. Prof. Langley has made splendid experiments on the top of Mount Whitney, at the height of 15,000 feet above the sea level, with his "Bolometer," and has made actual measurements of the wave lengths of radiant heat down to exceedingly low figures. I will read you one of the figures; I have not it by heart yet, because I am expecting more from him.* I learned a year and a half ago that the lowest radiant heat observed by the diffraction method of Prof. Langley corresponded to 28 one hundred thousandths of a centimetre for wave length, 28 as compared with red light, which is 7·3; or nearly four-fold. Thus wave lengths of four times the amplitude, or one-fourth the frequency per second of red light have been experimented on by Prof. Langley and recognised as radiant heat.

Photographic, or actinic light, as far as our knowledge extends at present, takes us to a little less than one half the wave length of violet light. You will thus see that while our acquaintance with wave motion below the red extends down to one quarter of the slowest rate which affects the eye, our knowledge of vibrations at the other end of the scale only comprehends those having twice the frequency of violet light. In round numbers we have four octaves of light, corresponding to four octaves of sound in music. In music the octave has a range to a note of double frequency. In light we have one octave of visible light, one octave above the visible range and two octaves below the visible range. We have 100 per second, 200 per second, 400 per second (million million understood) for invisible radiant heat, 800 per second for visible light, and 1,600 per second for invisible light.

One thing in common to the whole is the heat effect. It is extremely small in moonlight, so small that nobody until recently knew there was any heat in the moon's rays. Herschel thought it was perceptible in our atmosphere by noticing that it dissolved away very light clouds, an effect which seemed to show in full moonlight more than when we have less than full moon. Herschel, however, pointed this out as doubtful, but now, instead of its being a doubtful question, we have Prof. Langley giving as a fact that the light from the moon drives the indicator of his sensitive instrument clear across the scale and with a comparatively prodigious heating effect!

I must tell you that if any of you want to experiment with the heat of moonlight you must compare the heat with whatever comes within the influence of the moon's rays only. This is a very necessary precaution; if, for instance, you should take your Bolometer, or other heat detector, from a comparatively warm room into the night air, you would obtain an indication of a fall in temperature owing to this change. You must be sure that your apparatus is in thermal equilibrium with the surrounding air, then take your burning glass, and first point it to the moon and then to space in the sky beside the moon; you thus get a differential measurement in which you compare the radiation of the moon with the radiation of the sky. You will then see that the moon has a distinctly heating effect.

To continue our study of visible light, that is, undulations extending from red to violet in the spectrum (which I am going to show you presently), I would first point out on this chart that in the section from letter "A" to letter "D" we have visual effect and heating effect only; but no ordinary chemical or photographic effect. Photographers can leave their usual sensitive, chemically prepared plates exposed to yellow light and red light without ex-

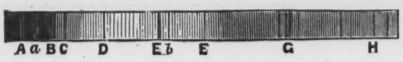

FIG. 2.—THE SOLAR SPECTRUM.

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* Exhibiting a large drawing, or chart, representing a red and a violet wave of light.

* Since my lecture I have heard from Prof. Langley that he has measured the refrangibility by a rock salt prism, and inferred the wave length of heat rays from a "Leslie cube" (a metal vessel of hot water radiating from a blackened side). The greatest wave length he has thus found is one one-thousandth of a centimetre, which is seventeen times that of sodium light. The corresponding period as about thirty million million to the second.—W.T.

periencing any sensible effect; but when you get toward the blue end of the spectrum the photographic effect begins to tell, more and more as you get toward the violet end. When you get beyond the violet there is the invisible light known chiefly by its chemical action. From yellow to violet we have visual effect, heating effect and chemical effect, all three; above the violet only chemical and heating effects and so little of the heating effect that it is scarcely perceptible.

The prismatic spectrum is Newton's discovery of the composition of white light. White light consists of every variety of colour from red to violet. Here, now, we have Newton's prismatic spectrum produced by a prism. I will illustrate a little in regard to the nature of colour by putting something before the light which is like coloured glass; it is coloured gelatin. I will put in a plate of red gelatin, which is carefully prepared of chemical materials, and see what that will do. Of all the light passing to it from violet to red it only lets through the red and orange, giving a mixed reddish colour.

Here is another plate of green gelatin. The green absorbs all the red, giving only green. Here is another plate absorbing something from each portion of the spectrum, taking away a great deal of the violet and giving a yellow or orange appearance to the light. Here is another absorbing out the green, leaving red, orange, and a very little faint green, and absorbing out all the violet.

When the spectrum is very carefully produced, far more perfectly than Newton knew how to show it, we have a homogeneous spectrum. It must be noticed that Newton did not understand what we call a homogeneous spectrum; he did not produce it, and does not point out in his writings the conditions for producing it. With an exceedingly fine line of light we can bring it out as in sunlight, like this upper picture, red, orange, yellow, green, blue, indigo and violet according to Newton's nomenclature. Newton never used a narrow beam of light, and so could not have had a homogeneous spectrum.

This is a diagram painted on glass and showing the colours as we know them. It would take two or three hours if I were to explain the subject of spectrum analysis to-night. We must tear ourselves away from it. I will just read out to you the wave lengths corresponding to the different positions in the sun's spectrum of certain dark lines commonly called "Fraunhofer's lines." I will take as a unit the one-hundred-thousandth of a centimetre. A centimetre is ·4 of an inch; it is a rather small half an inch. I take the thousandth of a centimetre and the hundredth of that as a unit. At the red end of the spectrum the light in the neighbourhood of that black line, A, has for its wave length 7·6; B has 6·87; D has 5·89; the frequency for A is 3·9 times 100 million million; the frequency of D light is 5·1 times 100 million million per second.

Now what force is concerned in those vibrations as compared with sound at the rate of 400 vibrations per second; suppose for a moment the same matter was to move to and fro through the same range but 400 million million times per second. The force required is as the square of the number expressing the frequency. Double frequency would require quadruple force for the vibration of the same body. Suppose I vibrate my hand again, as I did before. If I move it once per second a moderate force is required; for it to vibrate ten times per second 100 times as much force is required; for 400 vibrations per second 160,000 times as much force.

If I move my hand once per second through a space of a quarter of an inch a very small force is required; it would require very considerable force to move it ten times a second, even through so small a range; but think of the force required to move a tuning fork 400 times a second; compare that with the force required for a motion of 400 million million times a second. If the mass moved is the same, and the range of motion is the same, then the force would be one million million million million times as great as the force required to move the prongs of the tuning fork. It is as easy to understand that number as any number like 2, 3, or 4.

Consider gravely what that number means and what we are to infer from it. What force is there in space between my eye and that light? What forces are there in space between our eyes and the sun and our eyes and the remotest visible star? There is matter and there is motion, but what magnitude of force may there be?

I move through this "luminiferous ether" as if it were nothing. But were there vibrations with such frequency in a medium of steel or brass, they would be measured by millions and millions and millions of tons action on a square inch of matter. There are no such forces in our air. Comets make a disturbance in the air and perhaps the luminiferous ether is split up by the motion of a comet through it. So when we explain the nature of electricity, we explain it by a motion of the luminiferous ether. We cannot say that it is electricity. What can this luminiferous ether be? It is something that the planets move through with the greatest ease. It permeates our air; it is nearly in the same condition, so far as our means of judging are concerned, in our air and in the inter-planetary space. The air disturbs it but little; you may reduce air by air pumps to the hundred-thousandth of its density, and you make little effect in the transmission of light through it. The luminiferous ether is an elastic solid. The nearest analogy I can give you is this jelly which you see.* The nearest analogy to the waves of light is the motion, which you can imagine, of this elastic jelly, with a ball of wood floating in the middle of it. Look there, when with my hand I vibrate the little red ball up and down, or when I turn it quickly round the vertical diameter, alternately in opposite directions—that is the nearest representation I can give you of the vibrations of luminiferous ether.

Another illustration is Scottish shoemaker's wax or Burgundy pitch, but I know Scottish shoemaker's wax better. It is heavier than water and absolutely answers my purpose. I take a large slab of the wax, place it in a glass jar filled with water, place a number of corks on the lower side and bullets on the upper side. It is brittle like the Trinidad pitch or Burgundy pitch which I have in my hand. You can see how hard it is, but if left to itself it flows like a fluid. The shoemaker's wax breaks with a brittle fracture, but it is viscous and gradually yields.

What we know of the luminiferous ether is that it has the rigidity of a solid and gradually yields. Whether or not it is brittle and cracks we cannot yet tell, but I believe the discoveries in electricity and the motions of comets and the marvellous spurts of light from them, tend to show cracks in the luminiferous ether—show a correspondence between the electric flash and the aurora borealis and cracks in the luminiferous ether. Do not take this as an assertion, it is hardly more than a vague scientific dream: but you may regard the existence of the luminiferous ether as a reality of science, that is, we have an all-pervading medium, an elastic solid, with a great degree of rigidity; its rigidity is so prodigious in proportion to its density that the vibrations of light in it have the frequencies I have mentioned, with the wave lengths I have mentioned.

The fundamental question as to whether or not luminiferous ether has gravity has not been answered. We have no knowledge that the luminiferous ether is attracted by gravity; it is sometimes called imponderable because some people vainly imagine that it has no weight. I call it matter with the same kind of rigidity that this elastic jelly has.

Here are two tourmalines; if you look through them toward the light you see the white light all round, *i.e.*, they are transparent. If I turn round one of these tourmalines the light is extinguished, it is absolutely black, as though the tourmalines were opaque. This is an illustration of what is called polarisation of light. I cannot speak to you about qualities of light without speaking of the polarisation of light. I want to show you a most beautiful effect of polarising light, before illustrating a little further by means of this large mechanical illustration which you have in the bowl of jelly. Now I put in the lantern another instrument called a "Nicol prism." What you saw first were two plates of the crystal tourmaline which came from Brazil, I believe, having the property of letting light pass when both plates are placed in one particular direction as regards their axes of crystallisation, and extinguishing it when it passes through the first plate held in another direction. We have now an instrument which also gives rays of polarised light. A Nicol prism is a piece of Iceland spar, cut in two and turned, one part relatively to the other in a very ingenious way, and put together again and cemented into one by Canada balsam. The Nicol prism takes advantage of the property which the spar has of double refraction, and produces the phenomenon which I now show you.

I turn one prism round in a certain direction and you get light, a maximum of light. I turn it through a right angle and you get blackness. I turn it one quarter round again and get maximum light; one quarter more, maximum blackness; one quarter more, and bright light. We rarely have such a grand specimen of a Nicol prism as this.

There is another way of producing polarised light. I stand before that light and look at its reflection in a plate of glass on the table through one of the Nicol prisms, which I turn round—so. Now I must incline that piece of glass at a particular angle, rather more than 45°; I find a particular angle in which, if I look at it and then turn the prism round in the hand, the effect is absolutely to extinguish the light in one position and to give it maximum brightness in another position. I use the term "absolute" somewhat rashly. It is only a reduction to a very small quantity of light, not an absolute annulment as we have in the case of the two Nicol prisms used conjointly. Those of you who have never heard of this before would not know what I am talking about. As to the mechanics of the thing, it could only be explained to you by a course of lectures in physical optics. The thing is this, vibrations of light must be in a definite direction relatively to the line in which the light travels.

Look at this diagram, the light goes from left to right; we have vibrations perpendicular to the line of transmission. There is a line up and down which is the line of vibration. Imagine here a source of light, violet light, and here in front of it is the line of propagation. Sound vibrations are to and fro; this is transverse to the line of propagation. Here is another, perpendicular to the diagram, still following the law of transverse vibration; here is another circular vibration. Imagine a long rope, you whirl one end of it, and you send a screw like motion running along; you can get the circular motion in one direction or in the opposite.

Plane polarised light is light with the vibrations all in a single plane, perpendicular to the plane through the ray which is technically called the "plane of polarisation." Circular polarised light consists of undulations of luminiferous ether having a circular motion. Elliptically polarised light is something between the two, not in a straight line, and not in a circular line; the course of vibration is an ellipse. Polarised light is light that performs its motions continually in one mode or direction. If in a straight line it is plane polarised; if in a circular direction it is circularly polarised light; when elliptical it is elliptically polarised light.

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* Exhibiting a large bowl of clear jelly with a small red wooden ball imbedded in the surface near the centre.

With Iceland spar, one unpolarised ray of light divides on entering it into two rays of polarised light, by reason of its power of double refraction, and the vibrations are perpendicular to one another in the two emerging rays. Light is always polarised when it is reflected from a plate of unsilvered glass, or water, at a certain definite angle of 56° for glass, 52° for water, the angle being reckoned in each case from a perpendicular to the surface. The angle for water is the angle whose tangent is 1·4. I wish you to look at the polarisation with your own eyes. Light from glass at 56° and from water at 52° goes away vibrating perpendicularly to the plane of incidence and plane of reflection.

We can distinguish it without the aid of an instrument. There is a phenomenon well known in physical optics as "Haidinger's Brushes." The discoverer is well known in Philadelphia as a mineralogist, and the phenomenon I speak of goes by his name. Look at the sky in a direction of 90° from the sun, and you will see a yellow and blue cross, with the yellow toward the sun, and from the sun, spreading out like two foxes' tails with blue between, and then two red brushes in the space at right angles to the blue. If you do not see it, it is because your eyes are not sensitive enough, but a little training will give them the needed sensitiveness.

If you cannot see it in this way try another method. Look into a pail of water with a black bottom; or take a clear glass dish of water, rest it on a black cloth and look down at the surface of the water on a day with a white cloudy sky (if there is such a thing ever to be seen in Philadelphia). You will see the white sky reflected in the basin of water at an angle of about 50°. Look at it with the head tipped to one side and then again with the head tipped to the other side, keeping your eyes on the water, and you will see Haidinger's brushes. Do not do it fast or you will make yourself giddy. The explanation of this is the refreshing of the sensibility of the retina. The Haidinger's brush is always there, but you do not see it because your eye is not sensitive enough. After once seeing it you always see it; it does not thrust itself inconveniently before you when you do not want to see it. You can readily see it in a piece of glass with dark cloth below it, or in a basin of water.

I am going to conclude by telling you how we know the wave lengths of light and how we know the frequency of the vibrations. We shall actually make a measurement of the wave length of the yellow light. I am going to show you the diffraction spectrum.

You see on the screen,* on each side of a central white bar of light, a set of bars of light variegated colours, the first one, on each side, showing blue or indigo colour, about four inches from the central white bar and red about four inches farther, with vivid green between the blue and the red. That effect is produced by a grating with 400 lines to the centimetre, engraved on glass, which I now hold in my hand. The next grating has 3,000 lines on a Paris inch. You see the central space and on each side a large number of spectrums, blue at one end and red at the other. The fact that, in the first spectrum, red is about twice as far from the centre as the blue, proves that a wave length of red light is double that of blue light.

I will now show you the operation of measuring the length of a wave of sodium light, that is a light like that marked "D" on the spectrum, a light produced by a spirit lamp with salt in it. The sodium vapour is heated up to several thousand degrees, when it becomes self luminous and gives such a light as we get by throwing salt upon a spirit lamp in the game of snap dragon.

I hold in my hand a beautiful grating of glass silvered by Liebig's process with metallic silver, a grating with 6,480 lines to the inch, belonging to my friend Prof. Barker, which he has kindly brought here for us this evening. You will see the brilliancy of colour as I turn the light reflected from the grating toward you and pass the beam round the room. You have now seen directly with your own eyes these brilliant colours reflected from the grating, and you have also seen them thrown upon the screen from a grating placed in the lantern. With a grating of 17,000 lines—a much greater number of lines per inch than the other—you will see how much further from the central bright space the first spectrum is; how much more this grating changes the direction or diffraction of the beam of light. Here is the centre of the grating, and there is the first spectrum. You will note that the violet light is least diffracted and the red light is most diffracted. This diffraction of light first proved to us definitely the reality of the undulatory theory of light.

You ask why does not light go round a corner as sound does. Light does go round a corner in these diffraction spectrums; it is shown going round a corner, it passes through these bars and is turned round an angle of 30°. Light going round a corner by instruments adapted to show the result, and to measure the angles at which it is turned, is called the diffraction of light.

I can show you an instrument which will measure the wave lengths of light. Without proving the formula, let me tell it to you. A spirit lamp with salt sprinkled on the wick gives very nearly homogeneous light, that is to say, light all of one wave length, or all of the same period. I have a little grating which I take in my hand. I look through this grating and see that candle before me. Close behind it you see a blackened slip of wood with two white marks on it ten inches asunder. The line on which they are marked is placed perpendicular to the line at which I shall go from it. When I look at this salted spirit lamp I see a series of spectrums of yellow light. As I am somewhat short-sighted I am making my eye see with this eyeglass and the natural lenses of the eye what a long-sighted person would make out without an eyeglass. On that screen you saw a succession of spectrums. I now look direct at the candle and what do I see? I see a succession of five or six brilliantly coloured spectrums on each side of the candle. But when I look at the salted spirit lamp, now I see ten spectrums on one side and ten on the other, each of which is a monochromatic band of light.

I will measure the wave lengths of light thus. I walk away to a considerable distance and look at the candle and marks. I see a set of spectrums. The first white line is exactly behind the candle. I want the first spectrum to the right of that white line to fall exactly on the other white line, which is 10 inches from the first. As I walk away from it I see it is now very near it; it is now on it. Now the distance from my eye is to be measured and the problem is again to reduce feet to inches. The distance from the spectrum of the flame to my eye is 34 feet 9 inches. Mr. President, how many inches is that? 417 inches, in round numbers 420 inches. Then we have the proportion, as 420 is to 10, so is the length from bar to bar of the grating to the wave length of sodium light. That is to say, as 42 is to 1. The distance from bar to bar is the 400th of a centimetre; therefore the 42nd part of the 400th of a centimetre is the required wave length, or the 16,800th of a centimetre is the wave length according to our simple, and easy and hasty experiment. The true wave length of sodium light, according to the most accurate measurement, is about a 17,000th of a centimetre, which differs by scarcely more than one per cent. from our result!

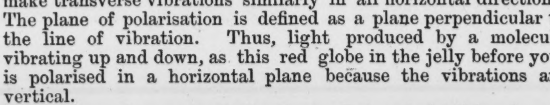
The only apparatus you see is this little grating; it is a piece of glass with four-tenths of an inch ruled with 400 fine lines. Any of you who will take the trouble to buy one may measure the wave lengths of a candle flame himself. I hope some of you will be induced to make the experiment for yourselves.

If I put salt on the flame of a spirit lamp, what do I see through this grating? I see merely a sharply defined yellow light, constituting the spectrum of vapourised sodium, while from the candle flame I see an exquisitely coloured spectrum, far more beautiful than I showed you on the screen. I see, in fact, a series of spectrums on the two sides, with the blue toward the candle flame and the red further out. I cannot get one definite thing to measure from in the spectrum from the candle flame as I can with the flame of a spirit lamp with the salt thrown on it, which gives, as I have said, a simple yellow light. The highest blue light I see in the candle flame is now exactly on the line. Now measure to my eye, it is 44 feet 4 inches, or 532 inches. The length of this wave, then, is the 532nd part of the 400th of a centimetre, which would be the 21,280th of a centimetre, say the 21,000th of a centimetre. Then measure for the red, and you would find something like the 11,000th for the lowest of the red light.

Lastly, how do we know the frequency of vibration?

Why, by the velocity of light. How do we know that? We know it in a number of different ways, which I cannot explain now because time forbids. Take the velocity of light. It is 187,000 British statute miles per second. But it is much better to take a kilometre for the unit. That is about six-tenths of a mile. The velocity is very accurately 300,000 kilometres per second; that is 30,000,000,000 centimetres per second. Take the wave length as the 17,000th of a centimetre and you find the frequency of the sodium light to be 510 million million per second. There, then, you find a calculation of the frequency from a simple observation which you can all make for yourselves.

Lastly, I must tell you about the colour of the blue sky which was illustrated by the spherule imbedded in an elastic solid. I want to explain to you in two minutes the mode of vibrations.



Vibrating Spherule Imbedded in an Elastic Solid.

FIG. 3.

Take the simplest plane-polarised light. Here is a spherule which is producing it in an elastic solid. Imagine the solid to extend miles horizontally and miles down, and imagine this spherule to vibrate up and down. It is quite clear that it will make transverse vibrations similarly in all horizontal directions. The plane of polarisation is defined as a plane perpendicular to the line of vibration. Thus, light produced by a molecule vibrating up and down, as this red globe in the jelly before you, is polarised in a horizontal plane because the vibrations are vertical.

Here is another mode of vibrations. Let me twist this spherule in the jelly as I am doing it, and that will produce vibrations, also spreading out equally in all horizontal directions. When I twist this globe round it draws the jelly round with it; twist it rapidly back and the jelly flies back. By the inertia of the jelly the vibrations spread in all directions and the lines of vibration are horizontal all through the jelly. Everywhere, miles away, that solid is placed in vibration. You do not see it, but you must understand that they are there. If it flies back it makes vibration, and we have waves of horizontal vibrations travelling out in all directions from the exciting molecule.

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* Showing the chromatic bands thrown upon the screen from a diffraction grating.

I am now causing the red globe to vibrate to and fro horizontally. That will cause vibrations to be produced which will be parallel to the line of motion at all places of the plane perpendicular to the range of the exciting molecule. What makes the blue sky? These are exactly the motions that make the blue light of the sky which is due to spherules in the luminiferous ether, but little modified by the air. Think of the sun near the horizon, think of the light of the sun streaming through and giving you the azure blue and violet overhead. Think first of any one particle of the sun and think of it moving in such a way as to give horizontal and vertical vibrations and what not of circular and elliptic vibrations.

You see the blue sky in high pressure steam blown into the air; you see it in the experiment of Tyndall's blue sky in which a delicate condensation of vapour gives rise to exactly the azure blue of the sky.

Now the motion of the luminiferous ether relatively to the spherule gives rise to the same effect as would an opposite motion impressed upon the spherule quite independently by an independent force. So you may think of the blue colour coming from the sky as being produced by to and fro vibrations of matter in the air which vibrates much as this little globe vibrates imbedded in the jelly.

The result in a general way is this: The light coming from the blue sky is polarised in a plane through the sun, but the blue light of the sky is complicated by a great number of circumstances and one of them is this, that the air is illuminated not only by the sun but by the earth. If we could get the earth covered by a black cloth then we could study the polarised light of the sky with simplicity, which we cannot do now. There are, in nature, reflections from seas and rocks and hills and waters in an indefinitely complicated manner.

Let observers observe the blue sky not only in winter when the earth is covered with snow, but in summer when it is covered with dark green foliage. This will help to unravel the complicated phenomena in question. But the azure blue of the sky is light produced by the reaction on the vibrating ether of little spherules of water, of perhaps a 50,000th or a 100,000th of a centimetre diameter, or, perhaps, little motes, or lumps, or crystals of common salt, or particles of dust, or germs of vegetable or animal species wafted about in the air. Now what is the luminiferous ether? It is matter prodigiously less dense than air—millions and millions and millions of times less dense than air. We can form some sort of idea of its limitations. We believe it is a real thing, with great rigidity in comparison with its density, and it may be made to vibrate 400 million million times per second, and yet with such rigidity as not to produce the slightest resistance to any body going through it.

Going back to the illustration of the shoemaker's wax; if a cork will in the course of a year push its way up through a plate of that wax when placed under water, and if a lead bullet will penetrate downwards to the bottom, what is the law of the resistance? It clearly depends on time. The cork slowly in the course of a year works its way up through two inches of that substance; give it one or two thousand years to do it and the resistance will be enormously less; thus the motion of a cork or bullet, at the rate of one inch in 2,000 years, may be compared with that of the earth, moving at the rate of six times 93,000,000 miles a year, or 19 miles per second, through the luminiferous ether; but when we have a thing elastic like jelly and yielding like pitch, surely we have a large and solid ground for our faith in the speculative hypothesis of an elastic luminiferous ether, which constitutes the wave theory of light.

MR. TATHAM: On behalf of the members of the Franklin Institute I desire publicly to return thanks to Professor Sir William Thomson for his instructive lecture.

REVIEWS.

Les Télégraphes. Par A. L. TERNANT. *I. Telegraphie Optique, Telegraphie Acoustique, Telegraphie Pneumatique, Poste aux Pigeons.* Deuxième Edition. Paris: Librarie Hachette et Cie, 75, Boulevard St. Germain.

The first edition of this work, which was published in 1881, although uniform in size with the new edition, contained a far larger amount of matter than the present volume, being more closely printed on thinner paper. The author's intention is, however, to issue a second volume in which the Electric Telegraph portion, including, we presume, the description of batteries, submarine cables, fire telegraphs, testing, &c., will be given, these subjects being absent from the present work. The division of the book into two volumes has enabled a thorough revision and partial re-arrangement to be carried out and additional matter to be added; thus the chapter dealing with telephones has been carried further up to date; we have also an interesting description of the pigeon post, of which we do not recollect any concise information having been previously published. M. Ternant's new book, indeed, as was the case with the first edition, has decidedly original matter in it, a point which tells very greatly in its favour. With the issue of the second volume a very complete little treatise will be formed which (if the new volume is as satisfactory as the first) will do the author considerable credit.

Magneto and Dynamo-electric Machines, with a description of Electric Accumulators. From the German of Glaser de Cew, by F. Krohn, and specially edited, with many additions, by PAGET HIGGS. London: Symons & Co., 27, Bouverie Street, E.C.

This book is the first volume of a "specialist's series" to be published by Messrs. Symons & Co. We are now getting so deluged with works on dynamos that little more can be said of each succeeding issue than that it is equal to its predecessors, and it has an addition of recent matter. In fact we are really getting but little more than new editions of a particular work, each edition being written or edited by a different author and published by a different firm. Page after page in the new work we come across the constantly-repeated tale, giving illustrated descriptions of the numerous varieties of dynamos. We have, however, a rather lengthier description of storage batteries than has hitherto been given in books of the class, a number of practical facts being stated. Some detailed information also on the construction of the different parts of the machines is perhaps rather more diffuse than usual, but the practical bearing of the facts stated is hardly sufficiently made clear. A great deal of the mathematical work given, and it is given rather freely, will, we think, hardly be appreciated by those who are likely to purchase the work, as it is much more of an ornamental than a practical character. Although we are not deeply impressed by Dr. Higgs's latest work, yet it will, we have no doubt, be valued by many, though it cannot be recommended on the score of its supplying a want.

The Popular Guide to the Telegraph and Postal Service; a manual of Elementary Instruction in Telegraph and Postal Duties. By WILLIAM LYND. London: Wyman and Sons, Great Queen Street, Lincoln's-Inn-Fields.

This book professes to be a concise manual of telegraph and postal duties, and the author has certainly justified the profession, for the work is very complete of its kind. Although, no doubt, a casual glance at the pages might give one the impression that the duties of a postal clerk are of a most exacting and onerous character, yet actually the work is far from being difficult, though, of course, a reasonable amount of care and intelligence is necessary. There are many persons who are desirous of earning a living by engaging in Postal duties, and to all such we would recommend the purchase of Mr. Lynd's guide.

The Disk: A Prophetic Reflection. By E. A. ROBINSON and G. A. WALL. London: Griffith, Farran, Okeden and Welsh, St. Paul's Churchyard.

The great success which has attended the quasi-scientific narratives of the talented author of "Twenty Thousand Leagues under the Sea," "A Voyage from the Earth to the Moon," &c., has not produced such a crop of imitators as might have been expected, probably because the marvellous combination of talents necessary to enable works of the kind to be written is quite unique. The production of Messrs. Robinson and Wall although not devoid of merit, cannot bear comparison with the productions of the master-mind of Jules Verne. The title of the book although, no doubt, striking, is not, we think, a particularly attractive one; and as the success of a work depends so greatly upon this, the selection is somewhat unfortunate. Of the scientific aspect of the book nothing need be said, as the knowledge of the authors does not seem to be very extensive. The romantic element is, of course, to be met with ; no production of the kind would be complete without it. Although we cannot speak with rapture of "The Disk," yet a spare hour might be passed without weariness in reading it.

NOTES.

Greenock Electric Lighting.—The Board of Police at Greenock is engaged in carrying out the electric lighting scheme for which it obtained a provisional order. Two Victoria machines, each producing a current of 100 ampères, with an electromotive force of 100 volts, are being erected in a building between Dempster Street and Prospect Hill Street, and are to be driven by water-power from the filters at Prospect Hill. The mains run down Captain Street, Roxburgh Street, and Ann Street—a distance of about half-a-mile. At first 25 street lamps will be lighted, and then the demands of private owners will be supplied, junction-boxes being laid at every corner for the connection of subsidiary circuits. The conductors are of the Berthoud-Borel type, made by the Kinetic Company, respecting which some correspondence has lately taken place and been reproduced in our columns. This installation is of special interest, as it will be worked under singularly favourable conditions. The local authorities have a plentiful supply of water-power, so that the usual outlay for fuel, stoker, and engine-driver will be entirely saved. The interest upon the original outlay will be small under the existing demand for municipal investments, and consequently the expenses will be limited to amortisation, depreciation, and lamp renewals. Mr. Edgar W. Beckingsale, of Bedford Park, London, is the contractor for the entire installation.

The Electric Light for Iron and Steel Works.—A contemporary states that a year or two since an electric light company was started upon the marshes at Middlesbrough to supply Brush lights on rental to the various ironworks around from a central station. £25 per annum per light was the charge made, plus the cost of carbons consumed. The North Eastern Steel Company has hitherto rented 18 lights—Gjers, Mills & Co., one, and two others are employed by neighbouring firms. But there are no symptoms of the demand extending, and the company is now endeavouring to sell its plant to a syndicate of its customers at a price considerably less than it cost. It is said that £3,000 has in all been expended. It has been found that gas lighting answers well enough for ironworks, especially if three-flame lights on Sugg's or Bray's principle be used in the more important places, and that it costs far less than electric lighting. For steel works, however, the electric light seems almost a necessity. In the end it is probable that the North Eastern Steel Company will buy up the electric light company's plant.

The Electric Light in Mills.—The electric light has recently been successfully introduced by Mr. Wilson Hartnell, Leeds, at Ferney Mill, Todmorden — Mr. Charles Crabtree's. The whole place is lighted from one dynamo machine, supplying current to some 268 20 candle-power Swan incandescent lamps, each taking an electromotive force of 110 volts. In the shed are some 500 looms, all of which are well lighted by these lamps, and the warehouse and other adjacent buildings are entirely illuminated in this manner. The dynamo is one of Crompton's latest improved type, the speed of which is 480 revolutions per minute. This is driven direct from the main-shaft driving the other machinery, and the lamps burn very steadily, owing to the large flywheel of the engine.

The Incandescent Electric Lighting Company.—This company—working under the Crompton-Winfield system—has given notice of a Bill in Parliament which considerably varies the terms of its order. It proposes that the Corporation shall purchase the undertaking within six months after the expiration of 35 years from the passing of the Act, instead of, as is now provided, six months after the expiration of 16 years. It asks, also, that the term for the deposit of separate capital shall be extended to two years after the proposed Act ; that power shall be taken to vary from time to time the assigned district, with the consent of the Corporation ; that it shall not be compelled to supply electricity to consumers for a longer period than twelve consecutive hours ; and that the limit within which the commencement of supply shall take place shall be extended to five years instead of two. The company has obtained the consent of the Corporation to extend the time during which the preliminary work of providing and fixing machinery and laying down mains is to be completed. It is not expected, says the *Engineer*, that any opposition will be taken to the scheme by the Corporation, although it is anticipated that they will have something to say upon the extended time allowed for purchase

Temesvar in Darkness.—Writing to the papers with respect to the telegram which lately appeared to the effect that the town of Temesvar, in Hungary, was left in darkness, in consequence of the break down of the electric light system, which had been established there by the International Electric Company, Mr. Frank Schloesser, Secretary of the Company, states that the interruption referred to, which occurred on one night only, was not caused by a break down of the electric light system, but by a sudden failure of water supply for boilers and condensers, consequent upon the blocking up of the Bega Canal by an exceptionally heavy fall of snow, followed by hard frost. With the exception of the above single interruption, against the repetition of which the necessary precautions have been taken, the lighting by electricity of the whole of the public thoroughfares of Temesvar (over 40 miles in length) has been in continuous and perfectly satisfactory operation since the 1st of November last. The experts called in by the Town Council to examine and report on the works were on the spot at the time of the accident, and were able to verify its cause. The result of the report they have since sent in has been a unanimous vote of the General Assembly of the Town Council to accept for a permanency the electric lighting of the streets, as complying with the terms of the contract made by the town with the International Electric Company, Limited. The first permanent establishment of a system of electric lighting for a whole town, says Mr. Schloesser, is a matter of considerable public, as well as historical importance, because most Continental concessions for the lighting of towns by gas contain a clause rendering it obligatory upon the concessionaires to supersede gas by any other system of illumination which may have proved itself superior by practical experience.

Electric Lighting in Australasia.—The Australasian Electric Light and Power Company has prepared a return of the lighting it has done in various parts of Australasia, and also of the work done by the Australian and Edison Indian and Colonial Companies. The first-named has carried out 32 installations, employing 319 arc and 1,295 incandescent lights, and of these 10 have resulted in loss, and 14 in profit, the remainder being in progress. The Australian Electric Company has carried out 16 installations, in which an aggregate of 60 arc and 2,132 incandescent lights are used, and has effected sales of lighting plant in 15 cases to a large extent to various mining companies.

The Ameer and the Electric Light.—The latest idea of the Ameer of Afghanistan is to illuminate Cabul by the electric light. It is stated that he has sent some officers to Bombay to make the necessary arrangements.

Electric Lighting at Hawick.—Consequent on the recent successful experiment by the Town Council in lighting the Tower Knowe and the west end of High Street, Hawick, by means of electric lamps, supplied by Messrs. Anderson and Munro, electricians, Glasgow, a meeting of shopkeepers and others interested in the electric light was held on Monday evening. Mr. Maben, chemist, made a statement to the effect that the lighting of his shop cost him £3 4s. 6d. annually, and that according to a calculation he had made to light his shop with electricity would cost £4 16s. 6d., the difference in favour of gas being 32s.; still he was willing to pay the difference for the electric light, which he considered would be better and steadier. During the conversation which ensued it was stated that the Town Council had under consideration the advisability of lighting the principal thoroughfares with electricity for a year as a further experiment, and ultimately it was agreed to wait and see what steps the Council might take.

Berlin partly Lit by Electricity.—The lighting of a portion of the business and fashionable quarter of Berlin by electricity has gained many friends. The contract with Messrs. Siemens and Halske, which has been several times renewed, expires on the 1st March, 1885, and the authorities, in view of the general approval, intend to continue the lighting. It is not known whether the town authorities will undertake it themselves, or hand it over to private undertakers, more than one of whom have tendered.

Lighting of the Havre Hospital.—The electric illumination of the new municipal hospital at Havre is just completed. The buildings are not favourably situated for the purpose, as they form a series of distinct pavilions separated by some considerable distance from one another. The conductors, therefore, have a total length of 6,000 to 7,000 metres (3·7 to 4·3 miles), the greater part being underground. Cruto incandescence lamps, manufactured by the firm of Mildé, are used. In the wards each lamp has a reflector; seven wards have three lamps each, five have two lamps, and four have one lamp. There are besides in the kitchen and in an adjoining room three suspended fittings, each carrying four lamps. The outdoor lights are formed of groups of two, four, or five lamps enclosed in lanterns of the form of the street lamps of Paris. To prevent the rain falling upon the lamps, there has been added to the lantern a kind of cone of enamelled iron, which serves at the same time as a reflector. At the garden gate there are two lanterns of five lamps, and two similar lanterns light the chapel; the alleys and promenades are, further, lighted by one chandelier of five lamps, two of four lamps, and thirteen of two lamps. The current is furnished by two Gramme machines, compound-wound, and the result is very satisfactory. The installation has been erected by the firm of Mildé, under the direction of their engineer, M. Desroziers, and of their Havre representative, M. Bricard.

Electrically Lighting Trains.—Electric light plant is being put down by Messrs. Heenan and Froude, of Manchester, for lighting railway carriages on the Great Eastern Railway. Seven trains have been running since 1st October without a hitch. The dynamos are driven by Messrs. Heenan and Froude's high-speed spherical "Tower" engines, engines and dynamos being 3 feet 3 inches long over all, by 13 inches wide, and 2 feet high. They are placed on the locomotive boiler behind the dome, and clear of the side view of the driver, as it occupies a centre position on the boiler. Steam is taken from the dome, and exhausts by the chimney. The wires and lamps are so arranged as not to prevent oil lamps from being put in at a moment's notice in the event of a train being divided from the main, and run on to a branch line; but the Great Eastern Railway Company contemplates applying the electric light to the whole of its trains.

The Commercial Advance of the Edison System.—The report of the trustees of the Edison Electric Light Company for the year ending September 30th is in print, and says the past year has been an important one in the way of progress, and especially in the readjustment of relations which had grown out of the past. One item of consequence was the arrangement made with the Isolated Company, regarding exploiting work, whereby the annual expenses of the Edison Company are reduced from about $100,000 to $25,000, exclusive of unusual legal or other expenses. The Edison Company has a proprietary interest of 51 per cent. in the capital of the Isolated Company. The profits of the latter were $35,000 the first six months of 1884, and are estimated the same to December 31st, making $70,000 for the year, which is equal to nearly 10 per cent. on the stock. This amount is needed to make up the company's deficit. There is greater promise of income from local and licensed lighting companies. There are eighteen of these companies having central stations, three being at Massachusetts, at Brockton, Lawrence, and Fall River. The licensed company in New York earned a profit of $10,429·46 in the first quarter of 1884, a profit of $7,251·57 the second quarter, $3,873·46 the third quarter, and an estimated profit for the fourth quarter of $9,600. The net loss in 1883 was $4,457·50. The capital of the New York company is $1,000,000, and its capacity 13,000 lamps. The capital of the Edison parent company is unchanged, being $1,080,000, of which $553,517·60 is paid for in cash, $347,450 is assured to T. A. Edison for patents, leaving $179,033 in the treasury due Mr. Edison, &c. The balance sheet shows the book debits and credits to be $1,720,346·32. The credits, consisting of $900,967·60 capital stock paid in, $761,108·14 in licenses from subcompanies, $43,654·92 dividends and royalties collected, and $14,615·66 in accounts payable. The stock of the Edison Company is now 40 bid, 75 asked.—*The Electrical World.*

The Electric Lighting Act.—Major Flood-Page, writing to the *Times* with respect to the report of the Dynamicables, discussed in our leading article last week, states that that report was written from purely a scientific point of view, and must not be taken as emanating from the committee of which Lord Thurlow is chairman, which will deal with the Electric Lighting Act and the Provisional Orders from a strictly commercial point of view. Lord Bury's committee has simplified the task of the other, he states, but there are several questions bearing very materially on the work of the electric companies which naturally find no place in the excellent scientific report referred to.

Electric Lighting in 1884.—The *Mechanical World* says:—"It may be pertinent to note that during the year the extension of electricity as a means of lighting has been of a very limited character, and that (as stated recently by the chairman of the London Gas Light and Coke Company) the amount of money spent on electric light experiments in 2½ years has reached the large total of £5,331,000, and the present price of electric stock is 1s. in the pound, as contrasted with the present price of the company's gas stock 42s. in the pound."

The Electric Light in the House of Commons.—It was intended to considerably extend the partial use of the electric light in the House of Commons before next session; but the Autumn session has prevented the work from being carried forward, and it is now indefinitely postponed.

Electric Light in Lanark.—A permanent and very successful electric lighting installation has recently been carried out in the small town of Lanark, the business premises of Messrs. Hunter and M'Morrison, ironmongers, having been completely fitted up with incandescence lamps. There are 22 lamps, each of 20-candle power. Sixteen lamps are always running, and the remaining six are disposed in different parts of the premises. The dynamo used is an "A" Gramme, which is capable of giving current to thirty 20-candle power lamps when running at the rate of 700 revolutions per minute. Power is obtained from a Tangye engine of two horse-power nominal, and fitted with patent governor. Besides the six incandescence lamps already referred to, which primarily form the auxiliary circuit, it also embraces a Jamin arc lamp of 2,000-candle power placed in the front shop on special occasions for lighting the street outside.

The Telephone in Japan.—The first telephone line ever constructed in Japan is now being built in Tokio.

The Telephone for Divers.—Some experimental trials are ordered to be carried on at Chatham Dockyard with a new telephonic diving apparatus, by means of which conversation can be kept up with divers when engaged in carrying out diving operations. The trials are to be made on board the *Pembroke*, flagship of the Steam Reserve, in the steam basin at Chatham.

Telephone Stamps.—A system has been devised by Mr. Alfred R. Bennett, of the National Telephone Company, for the utilisation of stamps in connection with the use of the telephone at call offices. For a conversation of three minutes' duration, a 3d. stamp is attached to a form hung in the office for the purpose, and an additional 1d. stamp for every minute over that time. The stamps are of neat design, bearing the head of Colonel Raynsford Jackson, chairman of the company, and are of four kinds—1d., 3d., 6d., and 1s. The forms constitute a simple method of checking the company's receipts, in order to arrive at the Government tax of 10 per cent.

Personal.—The King of Portugal has just conferred the honour of Cavalliero do Christo on Mr. Alan Danvers, engineer and manager to the Edison Gower-Bell Telephone Company at Lisbon. Mr. Danvers has received this distinction in consequence of the following interesting circumstances:—Some little time ago the King of Portugal was prevented attending the first performance of the opera *Lauriana*, through the death of the Princess of Saxony, and neither the king nor the other members of the royal family would have heard anything of the opera had not Mr. Danvers come to the rescue and suggested that he should telephone the opera from the house to the Ajuda Palace. The king, delighted at the proposal, immediately acquiesced. The result proved most satisfactory, as both the music and the words are stated to have been perfectly distinguishable; and the king shows his appreciation of the fact by conferring this honour of knighthood on Mr. Danvers.

The Telephone and Fire.—Mr. C. G. Wright, District Manager of the National Telephone Company, Limited, writes to the *Edinburgh Courant* with respect to a fire which occurred at the Tyrie Bleachworks, near Kirkcaldy, recently. It was stated that "on the burgh fire brigade arriving on the scene the roof was found to have fallen in," and that "a man was despatched on horseback for the Kirkcaldy fire brigade." Mr. Wright says:—The owners of the Tyrie Bleachworks were lucky in having a horse and rider so handy, but had they possessed communication with the Kirkcaldy Telephone Exchange (which is open day and night), the fire brigade would have arrived at the scene about the time that the man on horseback was galloping up to the fire station with the alarm, and the roof would probably have been standing now. A marked contrast to this occurrence was the fire at the Kirkcaldy Linoleum Company's works on June 30th last. In that case communication with the telephone exchange existed, and by its aid the burgh fire brigade and the private engines of several firms were called with such promptitude that although the building and contents were valued at £40,000, and the fire, when discovered, had obtained considerable hold, the total damage done was under £500.

Rating of Telephone Companies.—Mr. J. Russell Endean, chairman of the United Committee on Overhead Wires for the parishes of St. Marylebone, St. George, Hanover Square, and St. James, Westminster, writes to the *Times* on this subject, and after referring to the recent judgment given in the Court of Appeal by the Master of the Rolls, in the case of "The Lancashire and Cheshire Telephonic Exchange Company, Limited, *v.* the Overseers of the Poor of the Township of Manchester," to the effect that—"Everything connected with the working of the telephones was the exclusive property of the company, for whose benefit alone they were fixed; therefore the company was ratable, and the appeal must be dismissed," says:—As this judgment, if confirmed, will have an essential influence in future in the assessment of the liabilities of telephone companies to the local rates of London and of the provinces, and knowing that no rating claim has been enforced upon any London telephone company, I wrote to the Mayor of Manchester for information, seeing that, as the Manchester overseers had raised the question of liability to the rates, and so far successfully, a knowledge of the *modus operandi* by which they had determined the value for rating would be most probably of great service to overseers generally should they in future, as they most likely will, be called upon to value the property of the telephone companies passing through their respective districts. Through the kindness of the Mayor of Manchester I submitted the following questions to the overseers, and to those questions I now append a copy of the replies received:—1. Did the overseers, in making their assessment for Manchester, assess a certain sum on every wire belonging to the company?—No. 2. Or did they put the whole of the estimated value of the wires as one property into one sum and assess the rate on the gross value?—Yes. 3. Or did they fix a nominal rate simply to bring the company within the claimed liability to the rate?—A moderate sum of £2,000 per annum. 4. If each wire were assessed separately, or the whole were assessed in one sum at the ordinary rate upon the estimated value, how was this value ascertained?—See above. 5. In all the wires in or elevated over the streets and thoroughfares of your city, by what means do you know to whom each wire belongs, so as to assess the proper parties for the same?—Practically all are owned by the same company. Notice of appeal to the House of Lords has been given. The fact of the telephone system in Manchester belonging to one company greatly simplifies the matter for the authorities; but in London the duty of discovering to which company each wire belongs will entail great difficulty, as no record has been taken by any imperial or local authority of any overhead wire in London, while there are, it is asserted, many hundreds of miles of "dead" wires over the streets and thoroughfares for which it is difficult to find owners.

The American Bell Telephone Company.—This company has declared an extra cash dividend of 3 per cent., payable December 15th. The regular dividend of 3 per cent. was payable January 1st, making 5 per cent. for the year. The present capital of the American Bell Company is $10,000,000, of which $9,500,000 is paid in. It now asks for another $10,000,000, making $20,000,000 authorised. The new capital will be issued as required, and is expected to be used in perfecting the long distance service and increasing the lines and business.

Telegraph Revenue.—The receipts for the past year on the telegraph service have been as follows;—For the quarter ending March 31st, £390,000, against £395,000 in the corresponding quarter of 1883; to June 30th, £440,000, against £435,000; to September 30th, £485,000, against £485,000; to December 31st, £430,000, against £435,000. The revenue for the year, therefore, shows a net decrease of £5,000.

The Soudan Rebels.—The telegraph wire to Merawi, in the Soudan, has been cut by the rebels.

The Telegraph in Central Asia.—The *St. Petersburg Gazette* of December 31st, according to a Reuter's telegram, announced that an extraordinary advance of 100,000 roubles has been granted to General Komaroff for the construction of a telegraph line between Askabad, Merv, and Sarakhs.

The Commercial Cable Company.—The Mackay-Bennett cables were opened for traffic on 24th December. The regular rates to Great Britain, Ireland, France, and Germany, will be 40 cents per word, a reduction of 20 per cent. on the previously existing tariff. The press rate will be 20 cents per word for plain unabbreviated language; there will also be a deferred rate of 10 cents per word.

Reduction of Tariff.—The Direct United States Cable Company announces that until further notice the charge for the transmission of telegrams "*vià* Direct Cable" between Great Britain or Ireland and New York and Canada will be 1s. 8d. per word. The war of rate-cutting has thus commenced.

The New Portuguese-West African Cable.—The Portuguese Minister of the Colonies at Lisbon, on December 29th, went on board the steamer *Silvertown*, which is shortly to sail for Africa to lay the Senegal cable and to make soundings preparatory to the laying of the Portuguese cable. After inspecting the ship the Minister, who was accompanied by Mgr. Vanutelli, the Papal Nuncio, M. de Laboulaye, the French Minister, and Baron Greindl, the Belgian representative, delivered a speech, in which he expressed the hope that the civilising work about to be begun, the initiative of which emanated from Portugal, would be successfully accomplished. Portugal had already rendered services to humanity on the African continent, and it was to be hoped that this new line of electric communication would serve as a bond of union between Portugal and the Powers interested in the development of their West African colonies. The *Silvertown* arrived at Lisbon on the 24th ult. in the evening, but had to do quarantine till the 26th. She is expected home to-morrow, the 4th inst.

New Cable Steamer.—Messrs. Robert Napier and Sons, Govan, are building a steel screw steamer of 860 tons, and 1,400 horse-power, for the Eastern Extension Australasia and China Telegraph Company.

Cable Interruption.—At about 11 a.m. on the morning of the 28th November, the new cable to St. Vincent was suddenly interrupted. The tests pointed to the break being a very short distance from shore, though in comparatively deep water. Accordingly the *Kangaroo* arrived at Madeira, December 15th, and found the break to be a little over half a knot from the cable house. A curious feature in connection with this rupture, which *The Monthly Correspondent* hears was evidently the work of a ship's anchor, was that although the Madeira end of the break made "earth" after a fashion, the broken extremity of the St. Vincent end was completely sealed by the gutta-percha which had been pulled and pressed over it. A better or more effective seal, it is said, could not have been made by a joint, and on its being tested after being brought aboard, it showed no loss whatever.

Floods in India.—Many telegraph lines in Madras Presidency have been destroyed by floods.

License Fees in America.—The referee to whom was referred the suit brought by the city against the Bell Telephone Company and the Mutual Union and Western Union Telegraph Companies, in Philadelphia, to recover a license fee of $1 per year per pole and $2.50 per mile of wire, has filed his report. He says that the fees exacted are unreasonable and operate in substance as a tax; and he, therefore, is of opinion that their collection cannot be forced.

The Kinetic Engineering Company's Cables.—The following are the results of the insulation tests made on the cables laid in accordance with the Greenock Provisional Order, before leaving the factory. It was specified that the cables should have an insulation resistance of not less than 1,000 megohms per mile at ordinary temperature. The actual results obtained when tested under water were 1,925 metres of cable of one strand of 1·2 millimetres diameter, gave 25,000 megohms per kilometre; 457 metres of cable of 36 strands of 1·5 millimetres diameter, 6,500 megohms per kilometre; 465 metres of cable of 36 strands of 1·5 millimetres diameter, 5,800 megohms per kilometre; 582 metres of cable of 12 strands of 1·6 millimetres diameter, 12,500 megohms per kilometre; 584 metres of cable of 12 strands of 1·6 millimetres diameter, 12,500 megohms per kilometre. The insulation given is therefore from 3½ times to 15½ times better than was required. The Imperial Austrian Telegraph Department has just laid down in the Arlberg Tunnel seven miles of the No. 25 cable, consisting of three conductors, each of seven strands of No. 22 B.W.G. After the laying of the cable it was tested, and found to give an insulation of 7,000 to 8,000 megohms per kilometre for each conductor. The cable was delivered in lengths of 1,000 metres, so that there were ten joints. Tests were made after jointing and laying of each length, and it was found that the insulation resistance per kilometre remained the same after each joint. Since then a further order has been received from the Austrian Government for six and a quarter miles of No. 3 cable, consisting of one conductor of seven strands of half a millimetre diameter. This particular cable is largely used by the French Ministry of War.

Mistaken Identity.—A correspondent writes:—"The following extract is taken from the French *Figaro* of Wednesday or Thursday last week. I was always under the conviction that Prof. Morse, of America, who died some years back, was the inventor of the telegraphic instrument now used in all offices. I am, however, ready to be corrected:—'There was buried a few days ago, and no journal has, we believe, yet mentioned it, a man who has rendered very great service to science by the practical discoveries to which he devoted his life and his intelligence, M. Louis-Auguste Morse, the inventor of the system and of the telegraphic apparatus bearing his name. M. Morse was born at Liège, but he has lived in Paris for a long time, and it was in his room in the Rue Solférino that he died, by an attack of apoplexy, at the age of 58 years.'"

Institution of Civil Engineers.—At a students' meeting, on January 16th, a paper "On Secondary Batteries," by Mr. F. Geere Howard, will be read. Mr. W. H. Preece, F.R.S., will preside.

The Regent Street and City Subway.—Mr. L. H. Isaacs, the surveyor to the Board of Works for the Holborn District, has made a report to that Board in regard to this scheme. He gives it as his opinion that the suggested method of traction by cable is one which, recollecting the many mishaps which used to occur on the Blackwall Railway when worked by stationary engines at each end of the line, is not likely to be favourably received; but if it were contemplated to work the proposed railway by electricity, there can be no doubt that it would prove a great boon to Londoners generally, as freedom from the vapours which tend much to destroy the comfort of those travelling by the underground railways would be highly appreciated by the passengers. It is pointed out that the interference with the roads, sewers, and gas and water mains would be very great.

Professorial Appointment.—Mr. J. J. Thomson has been elected to fill the post of Cavendish Professor of Experimental Physics in the University of Cambridge in succession to Lord Rayleigh. A numerously signed requisition to Sir William Thomson to become a candidate was declined.

Serious Gas Explosions.—On Wednesday morning a series of gas explosions took place in the district of Wensley Fold, Blackburn. Fire got into the street gas main, causing explosions in two streets, some of the flags being turned completely over. In Wensley Fold three square yards of paving stones were blown into the air and rents made in the street. Some houses were damaged, and one was set on fire.

Electricity in America.—The several correspondents of *La Lumière Electrique*, who have been sent to report on the progress of electricity in America, have returned to Paris, and are preparing their reports.

The Swan Lamp in Boston.—The *Electrical Review* of New York states that the Swan Incandescent Electric Light Company at Boston, Mass., which stopped business some two or three months ago, has concluded to remove from Boston. It has made arrangement with the Brush Electric Light Company, of Cleveland, O., whereby that concern shall take possession of all the Swan Company's property there, and the plant is now being packed up and shipped as rapidly as possible. The stock of the Swan Company is held largely in New York and Cleveland, the Brush Company, it is said, being a large holder.

Obituary.—Mr. James Napier, of Glasgow, who has been long identified with chemistry and the manufacturing arts, especially with electro-metallurgy, has recently died at the age of about seventy-four years. Mr. Napier was long connected with the Philosophical Society of Glasgow, to whose proceedings he contributed many memoirs. He was also intimately associated with Anderson's College and the Technical School. He was author of "Ancient Workers in Metal," "The Manufacturing Arts in Ancient Times," and other works.

Underground Wires in America.—It is proposed to extend the time when telegraph and telephone wires in Philadelphia must be laid under ground till a year later than the recent law requires. The city solicitor has prepared an ordinance fixing January 1st, 1886, as the limit; and this is to be presented to the city council at the next meeting.

Electric Propulsion on the New York Elevated Roads.—Active preparations are being made to test electric locomotion on the elevated roads of New York City, and in about two months it is expected the first experiment will be tried on the Second Avenue line. A central rail twenty pounds heavier than those now in use will be laid between the rails from Chatham Square to the Harlem River terminus. Electricity will be conducted from the dynamos to the central rail by a large wire. The rail will be insulated, but the present tracks will remain as at present. All the electric railway companies will be allowed equal facilities for experiments with the motors, and the expense of laying the third rail will be divided between them. A commission to be selected by the companies will decide on the relative merit of the inventions. After this decision, a company will be formed to control all the patents of the several companies for this country, and for these rights each company will receive stock in the new company in proportion to the value of the property and patent rights conveyed by it.

United States Signal Bureau.—Prof. T. C. Mendenhall, *Science* states, has been appointed chief electrician of the U.S. Signal Bureau.

M. Marcel Deprez.—This eminent French electrician has been elected a member of the consultative railway commission in the place of the late M. Henri Lartigue.

The Earthquakes in Spain.—Owing to bad weather telegraphic communication in Spain has been much delayed, and information respecting the recent earthquakes has been consequently imperfect.

The Universal Electric Company, Limited.—Lords Mure, Shand, and Adam, a few days ago, disposed of an application in the Scottish courts, which raised questions between creditors of the above company as to their respective rights to be ranked preferential on the proceeds of the sale of certain poinded machinery of the company. William Clark and others, of Glasgow, were the compearing creditors, and Hinde, Milne and Co., solicitors, Manchester, as assignees of Wm. Mure and Co., engineers, Manchester, were the respondents. It appears that in November, 1882, William Mure and Co. obtained a decree against the electric company for payment of a debt due to them. On 5th December, a poinding of the company's machinery was executed, but the sale was interdicted by order of the court, the company having gone into voluntary liquidation under judicial supervision. Thereafter an arrangement was come to under which Mure and Co. agreed that the articles poinded should be taken as of the value of £337 10s. Wm. Clark and others now claimed to be ranked *pari passu* with Hinde, Milne and Co. upon this fund, grounding their claim upon the provisions of the 12th section of the bankruptcy statute.

Wire Drawing.—The *Times* states that iron and steel wire drawers at Birmingham have been suffering greatly for some time past from the severity of the German competition, but that they have now succeeded in bringing the cost of production down to a level which defies their competitors so far as the inland markets of this country are concerned. German wire, quality for quality, is still cheaper than English wire, but the cost of carriage from Germany to this country turns the scale against the foreigner, whose competition is now only formidable in foreign and colonial markets.

Lighthouse Illumination.—Professor Tyndall, upon the question of illuminants for lighthouses, says :—The vital question is, not what the electric light can do in a clear atmosphere, where its dazzling brilliancy is not only not needed, but is often a nuisance to the sailor, but whether that light is of the quality best suited for the penetration of a turbid atmosphere. The ratio of the more highly refrangible rays in the electric light to the total radiation is vastly greater than in the flames of either gas or oil; and these highly-refrangible rays are demonstrably most powerfully intercepted by the minute particles which constitute a fog. It is, therefore, on the face of it, conceivable that a light of greatly inferior intensity in clear weather, might, through its richness in rays of low refrangibility, equal, or even surpass, the electric light in some seasons of fog.

The Telegraph in China.—The *Times*, in its *resumé* of "Business in 1884," mentions, as a noteworthy fact, that in August a telegraph station was opened at Pekin, the Capital of the Celestial Empire having until the past year been kept free from the presence of the electric wire.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Union Electric Light and Power Company, Limited.—An order of the Chancery Division of the High Court of Justice, dated 6th ult., and filed on the 24th ult., directs that the voluntary winding up of the company be continued, but subject to the supervision of the Court. It is also ordered that the costs of the petitioners, and of the contributories supporting the petition, be taxed by the taxing master, and paid out of the assets of the company, and in such taxation only one set of costs be allowed to the contributories.

Western Counties and South Wales Telephone Company, Limited.—The registered office of this company is situate at 16, High Street, Bristol.

CITY NOTES, REPORTS, MEETINGS, &c.

Australasian Electric Light and Power Company, Limited.

THE third ordinary general meeting of this company was held at the offices, 41, Coleman Street, E.C., on Tuesday afternoon. Mr. Latimer Clark presided, and there was a fairly large attendance of shareholders.

Mr. J. H. Duncan, the secretary, having read the notice convening the meeting,

The Chairman asked that the report and accounts might be taken as read.

A Shareholder said before he acquiesced in that he must ask the Chairman for the letter of Messrs. Deloitte, Dever, Griffiths and Co., the auditors, which accompanied their report. They could not take as read that which they had not seen.

Mr. Duncan having read the letter, the report was then taken as read. It was as follows :—

" The directors beg to submit the balance-sheet and statement of profit and loss up to 30th June last. These accounts show a further expenditure of £6,886 15s. 1d. in opening up and extending the business of the company in Australia, and provide for writing off the loss in connection with the New Zealand Company, and in respect of the Sellon-Volckmar contract, both of which matters have been already reported on to the shareholders.

" The directors have to report that their confidence in the steady development of electric lighting in the Colonies continues to be maintained. The pledge of not embarking in costly experimental or probationary installations has been adhered to, and contracts for lighting, yielding fair profits, immediate and prospective, have been obtained.

" In the Australian business of the company the gross profits made have been generally good, but the expenses of the administration, and losses on lighting contracts undertaken for exhibition purposes in the earlier times, have more than absorbed these gains.

" The most serious check to an extended march of the enterprise has to be charged to the lack of spirit for a long time shown in the general adoption of the industry in this country, but the growing appreciation of electric light now becoming evident in England (and much more so in America), is daily exercising its influence in the Colonies.

" The reduction of standing charges has been made the persistent aim of the board, and the general outgoings have, it is considered, been reduced to the lowest practicable limit consistent with the work in hand and in treaty. It must be borne in mind, however, that the Melbourne amalgamation was effected only in May, and that, therefore, practically no economies show in the present account, these being to 30th June. The full extent of the reductions which have been put in force is only *now* beginning to be felt, as engagements for premises, and agreements with agents, engineers, and employees had, of course, to be respected. Along with these reductions the directors have subjected their own fees to a further abatement, the amount now paid under this head being one-third of that provided by the constitution of the company.

" The amalgamation with the Australian Electric Company (Swan system) in Victoria has been carried through with good results, but not without the delays ordinarily attendant upon the carriage of a matter of importance at a distance. The general manager of this company was elected to a seat on the board of the local company, and acts in the most cordial harmony with them.

" The lighting station of the local company is being extended and re-organised, as several contracts, taken when in competition with this company, were found to be working at a loss. By last advices these contracts were being terminated and replaced by others on a remunerative basis, the general manager reporting that there is now no difficulty in obtaining such contracts. Great importance is attached to the prompt development of this station, as upon its success will follow, according to a general concurrence of competent opinion, a large extension of similar enterprises, supported by local capital.

" It has been decided by the directors of the local company to separate the factory from the lighting station, so as to give freer scope to both, and in anticipation of larger demands upon them in the near future. It is satisfactory to be able to report that the staff has been, and is being, kept in active employment upon various new installations, foremost among them being two large contracts obtained since the amalgamation, viz., the Victorian Houses of Parliament and the Melbourne General Post Office.

" The business in the other Colonies also is looking well. The extensive drought in Australia has no doubt affected all branches of trade there, but there is every expectation, in consequence of recent rains, of a return of good seasons and local prosperity. A firm foothold has now been established in the most important quarters, and the general manager is confident of being able at least to meet the expenses of the coming year out of business already obtained and that in negotiation, so that all in excess of this should now be net profit.

" The original contract with Messrs. Clark, Muirhead & Co., involving obligations to employ that firm as sole manufacturers, and to divide profits with them, has been by mutual consent terminated.

" Upon the liquidation of the Eastern Company, an important purchase has been made of plant manufactured for that company under special license from the Brush Corporation. This purchase has been arranged upon very advantageous terms, and the directors anticipate exceptional profits to be realised from the re-sale.

" Mr. Robert Hammond, who was requested, in accordance with the resolution of the last general meeting, to join the board, found himself unable to devote the time necessary for the duties of a director, but has acted since the meeting as consulting shareholder as occasion has arisen. He has recently, however, intimated that, owing to the increasing pressure of the business of his own company, he cannot continue to give the attention required for advising upon subjects which demand examination of considerable detail. The directors, in deference to the wishes of shareholders expressed at the last meeting, would therefore welcome the appointment, either of another nominee of the shareholders (preferably a large holder of original shares), to join the board, or of a small committee of consulting shareholders, to advise in the place of Mr. Hammond. This is of the more consequence, as several matters of importance are now in course of negotiation which are hardly ripe for public discussion, but which might well be submitted to such a committee."

The Chairman said he had first to explain why he occupied the chair. He was very sorry to say that his colleague, Mr. Want, who had so ably filled the chair so long, found it necessary, from pressure of other business, to resign, and in consequence of that resignation he (Mr. Clark) had been requested to take the chair. The report, he must say, was not a pleasant one, nor was the duty he had to fulfil a pleasant one. Anything more gloomy than the report they seldom saw. No doubt, the patents for which they had paid so much of their large capital had turned out almost worthless on their hands. They went into the business in a moment of enthusiasm with thousands of others, and he did not know who was most to blame. They had all been under the impression that it was going to be a good thing for them, but they had learnt to their sorrow that it was the reverse. The only gleam of satisfaction to him was that it might have been much worse. (" We don't see it.") He saw it very clearly. In his individual case he applied for ten times the number of shares allotted to him, and he was very glad now that they had not been allotted to him. If there had not been that enthusiasm excitement and rush, and the capital eight times over applied for, he would have had the whole amount he applied for and been very severely bitten for his pains. They all knew that they expected to make a great fortune by the sale of concessions in Australia. At that time any form of concession could have been sold in London for any price. They, simpletons as they were, thought they had nothing to do but to send them out to Australia, and there would be the same rush there. They sent a gentleman who knew Australia well, Sir Julius Vogel (hisses), out to sell concessions. But while he was on his journey the whole bubble collapsed, and shares in every company fell down ruinously in price. When he got to Australia he found that telegrams had preceded him with information of what had taken place in London, and he found insuperable difficulties in the way of selling concessions. The board pressed him very much to form companies if he could do so—pressed him, perhaps, too hardly, for in a hasty moment he formed the New Zealand Company, which they saw written off for £17,000 or £18,000. Unfortunately, he arranged that in such a form that this company was liable to pay on shares. He then tried by installations of the electric light to get the public to take it up, and in doing so incurred the greater part of the losses shown, £27,000. He entered into contracts which he well knew to be unprofitable, but which were really intended to introduce the light in Australia. With respect to this £27,000, if they had chosen to cook the accounts, it would have been very easy to make it look less, for it was expended in work which was of the nature of an advertisement. Although they had put it all down to profit and loss, they were really entitled under the circumstances to have portion of it charged to capital account. He wanted here to divide the subject into two parts. At present, he had been talking about nothing but the past. But they had two things to look to—the past and the future—and he wanted to impress on their minds as strongly as he knew how, that they were two distinctly different things. Everything was against them in the past, and they had fearlessly written everything down to profit and loss account, whereas they might have put it off and made it look more hopeful. The future was a very different thing. If they looked to the past, and questioned him as to it, they would have none but gloomy answers. But if they would bear with him and look to the future they would see something brighter. Replying to an interruption, he said the board told them at the last meeting that there would be a loss of £5,000 ; that had been exceeded by £1,800. But they had very great hopes for the future. They held those hopes in March last, when they called them together and obtained their sanction to the amalgamation with the Australian Company, and they held them still. They had many grounds for doing so. First of all, electric lighting business was reviving ; business generally was reviving. The amount of electric lighting being done in this country was more than, perhaps, many of them were aware ; although this was not executed by public companies, but to a very large extent by private firms. The electric light had taken root and was going to grow. They were not bound to any system whatever. It was true they paid enormous sums for the Brush patents, but they were perfectly free to adopt any other system. They had excellent officers in Australia, and also a competent committee of management in Sydney, composed of the most influential men of Sydney. They had been reducing the expenses very much. The accounts were made up to June 30th, so that the effect of these reductions was not apparent in them. They had been rapidly getting rid of unprofitable work, and were taking nothing that did not yield a profit. The principal profits arose from sales, and that was the class of business they were doing now. The lighting of the Parliament houses and General Post Office at Melbourne, although resulting in a loss to them, had enabled the Australian Company to obtain profitable contracts for lighting those two places. Wherever the light had been installed in Australia it had given great satisfaction; there had been none of those breakdowns they constantly heard of in this country. With respect to the future, they had an excellent arc and incandescent system, and could do lighting now of every kind extremely well. When the board met them last time, they had no incandescent system. The Brush system which they bought turned out useless, and they suffered much in consequence. They had now sent out Victoria machines, also made by the Brush Company, Ferranti machines, and others, and were now doing business satisfactorily to the Australian public. In Australia they would make the expenses very different from what they now were. They estimated that they would be £3,000 a year; it was so large a territory to cover, that they could not greatly reduce them below that. And the expenses in London they estimated would be about £1,500. They had the strongest assurances from their agent that he saw his way by the business there to meet those expenses. They had £30,000 worth of plant in Australia now, taking it at the selling price; and if they could sell £10,000 worth, which the agent seemed confident of doing, they would not only pay expenses but show a profit. They knew pretty well what the future meant, and although he could not congratulate them, he thought the position was much more hopeful than any one would suppose from the balance-sheet. He moved the adoption of the report and accounts.

Mr. Cater, a director, seconded, and remarked that there were two or three things which the chairman, as vendor, could not reasonably touch upon. With regard to the termination of the contract with Messrs. Clark and Muirhead, he believed it was urged against Mr. Clark that he occupied a dual position as a director in this company and as a partner in the firm of Clark, Muirhead and Company. Mr. Clark's firm had been materially reconstituted, and that reproach could no longer apply. This company was now free to go to the best manufacturers for everything. Their reason for terminating the contract was that when Messrs. Clark, Muirhead and Company thought of establishing a factory, they were unable to gauge the possible local requirements of plant, and some delay occurred in the supply of plant to the company, which was tied to them; consequently it was thought better to terminate the engagement. Some short time ago the directors received a letter from some of the shareholders urging them to endeavour to obtain from the vendors part of the consideration paid for the patents. This they quite fell in with, and negotiations had been going on with the vendors for the return of a considerable part, say half of the shares, nominally of the value of £15,000. The negotiations had reached that point when they might be very well taken up by a committee of shareholders, or the directors it might please them to appoint. Negotiations had been proceeding for amalgamation with the Indian and Colonial Edison Company; and that might also be taken up by a committee of advice. Having spoken of his own faith in the future of the company, and of electric lighting generally, remarking that he intended to train two of his sons to be electrical engineers, he seconded the motion.

Mr. Stevens proposed, as an amendment, that a committee of *bonâ fide* shareholders be appointed to enquire into the past and present conduct and future prospects of the company, and expressed himself as greatly dissatisfied with the management of the company. He was quite sure the committee, if appointed, would not needlessly act in a hostile manner towards the present board.

Mr. Branscombe seconded the amendment, and stated that he did not receive the proxy sent by the board until the previous Saturday, on which day, to be of any legal value, it should have been in the hands of the chairman or secretary.

Mr. Wainwright criticised the accounts, drawing attention to the large sum (£360) put down as "miscellaneous expenses," after, apparently, everything had been stated in full.

Mr. Van Tromp said the observations made showed distinctly the absolute necessity for the appointment of a committee of investigation, and he put it to the directors whether it would not be better at once to agree to a committee, who would not necessarily be hostile to the board, but who would ascertain what the prospects were.

Mr. Ince thought they could hardly expect the directors to support the appointment of a committee of investigation unless they first passed and adopted the report. Practically the passing of the accounts meant nothing, except that they believed them to be correct.

Mr. Labouchere remarked that it would be a great pity to interfere with the action of the directors by not passing the report. He referred to the committee of investigation appointed in the case of the Metropolitan Brush Company, who were going to get thousands of pounds from the promotors, but from whom nothing had been heard for a length of time. He did not believe in committees unless they worked with the board.

Mr. Van Tromp said it did not appear to him that adjourning the passing of the accounts would in any way interfere with the progress of the company.

The Chairman said he very much appreciated the way in which Mr. Stevens had raised the question, and in which Mr. Van Tromp had spoken. The directors were quite in accord with them in the matter of fact, but they objected to the name of a committee of investigation, which inferred a slur on their conduct, and if the committee took that form they would have nothing further to do with it, but would decline re-election. They desired a committee of advice, who would have access to the accounts and to every information it was possible for them to have, and would have power to report.

After some further discussion the amendment was altered, and was passed in the following form:—"That a committee of *bonâ fide* shareholders be appointed to confer with the directors as to the past history and the present and future prospects of the company, and to report to a future meeting of shareholders."

Mr. Rae, who seconded the resolution in its amended form, said in Australia gas was 9s. per thousand feet, instead of 3s., as in England.

Mr. Van Tromp asked if it was distinctly understood that the committee would have power to examine the books and question the officers, though in name a committee of conference.

The Chairman: Absolutely so. Certainly.

The names of Messrs. Van Tromp, Pearson, Ince, Kish, and Stevens were suggested, and, meeting with the approval of the meeting, were accepted as forming the committee.

The Chairman then again moved the adoption of the report and accounts.

Mr. Van Tromp moved that they be adjourned for a month.

The Chairman: I must say the same with respect to this. Unless you adopt these, you do not adopt us any further. Proceeding to answer the questions put at an earlier stage of the meeting, he said the question of acquiring the Edison colonial patents was one in regard to which they thought the committee could greatly assist them. If they did acquire them they would not have to pay anything for them in the shape of cash, and they would be most materially assisted by what was stated to be the willingness of the founders to part with a large portion of the shares for that purpose. This company would have to part with some of its shares, but no cash. In answer to the query whether the directors gave much of their time to the company, he said they were excessively regular, and gave a great deal of time. With regard to the directors' fees suspense account, if the company was a success, they might feel justified in taking the money in suspense, but certainly not otherwise. He then explained the details of the accounts respecting which questions had been put. £350 of the £903 spent in cablegrams and telegrams was entirely due to the negociations for the acquirement of the interest in the Australian company; the distance of their ground of operations was the cause of the high expenditure on this item.

The Secretary said it was extremely unfortunate that they could not get the report out before Wednesday evening, in consequence of their not receiving the accounts from the other side in time. They desired to avoid the holidays in calling the meeting, but they were compelled to hold it before December 31st.

The Chairman then put the motion for the adoption of the report and accounts, when nine voted for it and twelve against, it being therefore declared lost.

The Chairman intimated that the board would retain office until other directors had been appointed, for which purpose another meeting would be called.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., were reelected, and a vote of thanks to the chairman having been accorded, the meeting terminated.

Mediterranean Extension Telegraph Company, Limited.—Creditors are required to send their claims to the liquidators, Mr. J. G. Griffiths and the Honourable A. G. J. Ponsonby, 4, Lothbury, E.C., by the 21st of January.

The Eastern & South African Telegraph Company, Limited.—It is notified that the coupons due on January 1st on the 5 per cent. mortgage debentures of this company will be paid by Messrs. Barclay, Bevan & Co., 54, Lombard Street.

Western Union Telegraph Company, Limited.—A dividend of 1½ per cent. on the capital stock is payable on the 15th of January next for the quarter ending the 31st instant.

West Coast of America Telegraph Company, Limited.—The coupons due on the 31st instant on the debentures will be paid by Messrs. Barclay, Bevan & Co.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 26th, were £2,557; after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th December, are £2,190, as compared with £2,251 in the corresponding period of 1883. The September receipts, estimated at £4,083, realized £4,143.

NEW PATENTS—1884.

16165. "Electric switches or cut-outs." E. C. Warburton. Dated December 9.

16175. "Electric current areometer or current weighing apparatus." F. P. E. De Lalande. Dated December 9. (*Complete.*)

16178. "Mechanical attachments for use with incandescence electric lamps." R. P. Sellon. Dated December 9. (*Complete.*)

16184. "Working punkahs by electro-magnets." C. Steiner. Dated December 9.

16237. "Magnetic electricity meter." W. C. D. Whetham. Dated December 10.

16276. "Voltaic batteries." D. G. Fitzgerald, T. J. Jones. Dated December 11. (*Complete.*)

16305. "Construction of electrodes for galvanic cells." S. H. Beckles. Dated December 11.

16337. "Producing and accumulating electricity." J. L. Huber. Dated December 11.

16361. "Obtaining electric currents for lighting and other purposes." R. Rose. Dated December 12.

16375. "Galvanic batteries." A. Schauschieff. Dated December 12.

16381. "Holders for electric incandescent lamps." C. F. Hodges. Dated December 13.

16396. "Winding electrical coils." W. F. King. Dated December 13.

16402. "Incubators with electrically-controlled heating apparatus." W. P. Thompson. (Communicated by L. Kelner.) Dated December 13.

16417. "Electric generators." H. Cushman, J. P. Hall. Dated December 13. (*Complete.*)

16435. "System of receiving-relay apparatus for long distance telegraph lines, and particularly submarine and subterranean cables." A. M. Clark. (Communicated by L. Maiche.) Dated December 13.

16437. "Preparation and application of materials, fabrics, and structures suitable for the construction of electric apparatus, cells, chambers, or dielectrics, and for other purposes." J. S. Williams. Dated December 13.

16438. "Electric accumulators or batteries; their construction and operation, and apparatus or means employed therefor or therewith." J. S. Williams. Dated December 13.

16463. "Electrodes and galvanic cells." S. H. Beckles. Dated December 15.

16498. "Portable electric lamps." A. V. Rose, G. F. Rose. Dated December 16.

16507. "Electrical gas pressure alarm." H. W. Bishop. Dated December 16.

16554. "Apparatus and process for the electrolytical separation and deposition of metals." A. M. Clark. (Communicated by B. Moebins.) Dated December 16.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

557. "Improvements in insulated wires for coils of electrical apparatus." A. Millar. Dated January 3. 2d. Consists in making insulated flat wires (of copper or other metal) in place of round wires as at present used, so as to obtain greater pliability and permit of coils being formed with less strain or pressure on the insulating covering than when round wires are employed.

10847. "An improved electric arc lamp." R. H. Gould. Dated August 1. 6d. In the improved lamp the carbon holders together with the carbons which they carry, are mounted in inclined positions in such a manner that they appear, looked at from the front, as the two equal sides of an isosceles triangle having its apex downwards. Each carbon is carried by a metal tube or stem and descends by gravity along a guide tube as the carbon burns away. At its lower end the carbon abuts laterally against a stop which is carried by an arm connected with the guide tube. The axes of the two carbons are not in the same plane but in transverse planes which would intersect each other if continued some inches below the points of the carbons. The carbons pass without touching at their lower ends, one a little in front of the other. One of the carbon holders is hung upon pivots so as to be movable, together with the stop or abutment which supports the lower end of the carbon, and when no current is passing, a spring operating against the pivotted carbon holder brings the two carbons into contact laterally near their lower ends. When the current passes, the arc is established by the separation of the carbons. This is effected by means of an electro-magnet, which attracting an armature attached to the pivotted carbon holder, overcomes the spring and produces an interval between the two carbons of permanent but adjustable length and suitable for the exhibition of the arc.

CORRESPONDENCE.

Secondary Batteries.

Seeing you have taken extracts from our correspondence with Messrs. Sellon and Reckenzaun in *Engineering* we send you a copy of our letter, which was written too late last week to appear in the early issue, and will be in this week's paper.

Elwell-Parker, Limited.

Commercial Road Works,
Wolverhampton, *December* 31*st*, 1884.

Secondary Batteries.

To the Editor of "Engineering."

Sir,—As far as we are able to gather from Mr. Reckenzaun's letter of the 6th inst., he appears to have obtained some of the earliest results of our labours (and the cells to which Mr. Sellon refers are apparently the same), we having made no cells of the kind he describes for some twelve months past. He then appears to have set them up after the plates had remained dry and exposed to the air long enough to *temporarily* impair their capacity. Perhaps Mr. Reckenzaun will give us particulars as to this.

He then seems to have charged them without giving them the usual reversal needed to bring them again to their normal active condition.

We infer this because the curious result Mr. Reckenzaun gives would be obtained under such treatment. But he did not order the cells of us, nor did he advise us that he was carrying out tests for his own information, or we should have as soon recommended an ordinary gas-holder, with its brick tank and complement of water, for portable purposes, as advised the use of the strong and heavy type of cells, intended solely for fixed installations, with plates designed to last many years.

However, we may here mention that these old cells still give back 80 ampere-hours at an even E. M. F. of about 2 volts after a charge of 88 ampere-hours—*showing an efficiency of at least 75 per cent.* But the efficiency of the Planté cells is so well known that we need say no more upon that point, and, as far as regards capacity as comparable with weight of plates, these plates have been made to *give out considerably more than five ampere-hours per pound of lead,* and we shall be most happy to supply a battery to Mr. Reckenzaun if he will order one.

We make no comment upon the Faure-Sellon accumulator, as we have had no personal experience whatever of it, and we agree entirely with Mr. Sellon that these matters "must eventually right themselves," but we fear that, did we leave his letters entirely unanswered, intending purchasers of the Planté cells might be deterred in so doing by Mr. Sellon's extraordinary statements.

Lead plates may be *roughened* by various mechanical and chemical means, but no process (except the original one set forth by Planté in his "Recherches sur l'Electricité," which, by itself, is too tedious and costly when applied to anything but the thinnest and least durable of lead plates to be of any commercial value) has an ulterior effect upon them at all similar to that produced by nitric acid, either alone or in combination with sulphuric acid, or by the vapour of the acid, and the marvellous capacity of the plates for taking the electric charge seems to be mainly owing to this ulterior action of the nitric acid. It is significant that the only process among the many tried by Planté for hastening the formation of his battery, which he considered so valuable that he at once patented it both in France and in this country, was the use of nitric acid; and the only process patented by Parker and Elwell—after trying all kinds of means for obtaining great extent of surface, &c.—was the use of combined nitric and sulphuric acids.

If Mr. Sellon has advanced the cause of electricity "for the love of the thing," so have Monsieur Planté and Mr. Parker—both having devoted quite as much of their lives to the subject—and their "care, integrity and reliability," cannot be called into question any more than that of Mr. F. V. Anderson or Mr. Reckenzaun; so, when Planté gives the loss between quantity and current put into his cells and that given back as 9 per cent. only, we may take it for granted that it is so. But, at the same time, we shall be quite willing to submit a battery for a prolonged and thorough testing by independent authorities, as suggested by Mr. Sellon, if the Electrical Power Storage Company will do likewise.

With regard to rate of charge and discharge, which we regret is untouched upon by Mr. Sellon, if we take the figures given by Mr. Reckenzaun for the Faure-Sellon cells, the Planté cells will take in and give out safely a far greater current, in a given period, than the Faure-Sellon.

We notice that the figures given by Mr. Anderson show an efficiency of $\frac{1{\cdot}94 \times 300}{2{\cdot}3 \times 400} = 63$ per cent. only, for the Faure-Sellon cells (and we presume these cells were supplied him for testing), whereas the *average efficiency* of the Planté cells is at least 70 per cent., *and may be much higher under special circumstances.*

As regards cost, we should like to know how long the Faure-Sellon plates last when charged and discharged to their full extent every day. However, taking the Faure-Sellon cell at 60s.

as giving a maximum of 300 ampère hours useful current, and the old form of Planté-Parker-Elwell cell at 25s. as giving a maximum of 120 ampère hours, there does not appear to us to be much difference either in first cost or weight of plates per ampère hour capacity.

In conclusion, we must say that if *we* chose to obtain some Faure-Sellon cells, kept the plates dry for a few months, and then charged them up, or put them into any expert's hands for that purpose, we think a still more curious result might be shown than that obtained from the Planté-Parker-Elwell cells as tested by Mr. Anderson and Mr. Reckenzaun.—Yours faithfully,

ELWELL-PARKER, LIMITED.

The Electric Lighting Act Committee.

With reference to the letter from Mr. H. F. Joel, which appears in your last issue, may I be permitted to point out that the premises upon which that gentleman bases his arguments can scarcely be considered as being in accordance with the facts. From Mr. Joel's statements it is to be inferred that the committee of which Lord Thurlow is chairman, is controlled by the Anglo-American Brush Electric Light Corporation, and the Edison and Swan United Electric Light Company, and that all the members of the executive "belong to, or are connected with, one or the other of the two companies before mentioned," and that "in its present form the executive committee only speaks for the two companies, and only represents company interests." How far this statement is correct can be determined by reference to the list of members of this committee, which has already appeared *in extenso* in the ELECTRICAL REVIEW, and from which it will be seen that the committee consists at present of 45 members, of whom only 13 are, so far as I know, either directly or indirectly connected with the two abovementioned companies; that out of about 20 English electric lighting companies to be found in the directory, about 15 are represented on the committee; that several private electric lighting firms (like Messrs. Crompton) are represented, and that among the members are one of the vice-presidents of the Institution of Civil Engineers, one of the vice-presidents of the Society of Telegraph Engineers and Electricians, and many of the foremost scientific and legal authorities upon the subject of electric lighting legislation. The executive committee was appointed from the full list of members, by ballot, at a representative meeting of the committee, and consists of ten members, two of whom are associated with the Anglo-American Brush Electric Light Corporation, two with the Edison and Swan Company, one with the Hammond Company, and one with the Electrical Power Storage Company; the four remaining members being Sir Frederick Bramwell, Mr. R. Campbell, Mr. R. E. Crompton, and Captain Douglas-Galton, C.B.

I merely wish to add that the formation of this general committee is only one more step in the progress which a combination of electric lighting companies and others have already made in the direction of reform in the interests of the industry generally, and is the immediate result of the interview which they had with the President of the Board of Trade a few weeks back. This committee has already, therefore (apart from its influential and representative character), a *locus standi* which will add weight to its deliberations, and doubtless secure for its decisions the especial consideration of the Board of Trade.

E. Garcke.
Hon. Sec. to the Committee.

112, Belvedere Road, Lambeth, S.E.
December 31*st*, 1884.

Secondary Batteries.

On the 19th inst. you published an article on the electrical tramcar recently built by the Storage Company, in which you gave certain figures as to the depreciation of the cells which are likely to be misleading.

You say that owing to a new design lately introduced, the useful output for a given weight has been increased, without in any way sacrificing the *durability;* and later, that Mr. Reckenzaun has based his figures for working cost on a depreciation of 50 per cent. as a safe limit.

This would naturally imply that the cells used for lighting purposes would depreciate in the same ratio, which is far from being the case.

The type of plate manufactured by the Storage Company enables the conductor, and the active material, to be disposed to the best advantage, but the proportions are varied according to requirements.

The accumulators supplied for lighting purposes are made with a view to obtaining great durability coupled with a high effective return; whereas in the tramcar cells the first consideration is a rapid discharge from a minimum weight.

In the latter case the metal is distributed where most needed, but the same durability cannot be expected as with cells designed for lighting, or other purposes, where weight is of minor importance.

We have every reason to hope, however, that Mr. Reckenzaun's allowance for depreciation will be more than ample, as the cells which were first made have been in constant use for over three months, and show no signs of deterioration.

It is impossible to say definitely what the life will be of the plates manufactured for lighting purposes with the latest improvements, but it may be mentioned that, even with the older types, the positives frequently lasted 18 months, and there is little doubt that this will be exceeded with the plates now being supplied.

The depreciation is confined almost entirely to the positives, and the company has already made arrangements to meet their customers in this respect by quoting a special price for renewal plates.

Bernard Drake,
Managing Engineer, Electrical Power Storage Co.

The Bell and Edison Telephone Patents.

I can assure Major Barney and your correspondent "Common Sense" that my only object in this correspondence is to strip this subject of the complications by which the supporters of the United Telephone Company seek to surround it, and to show in their nakedness the patents upon which this great monopoly is based. Major Barney's remarks as to the "high standing" of your correspondents will apply equally to himself, and therefore we must be satisfied with the value which the force of our arguments command. I am well aware that Major Barney's knowledge of this subject is pre-eminent, but in attacking the substance do not let us waste our strength upon the shadow. In my opinion, until a flexible plate of inductive material, fixed as a drumhead, in combination with a magnet, and the plate held rigid by its circumference either by screws or equivalent means, can be proved to have been previously known, the Morgan Brown patent, as disclaimed, will stand good. In a common sense reading of the patent, and considering all the previous publications, I cannot see that the patent claims more. In considering the meaning of the words, "but subject always to the disclaiming notes," it should be borne in mind that the *claims* are practically the same as they were in the original specification, but that by the disclaimer these words have been inserted, and therefore obviously on a common sense reading they can have no other effect but to qualify, or deduct from, what was previously claimed. We should also bear in mind that in the reading of a patent the Judge can only apply what *we* do—a common sense view of its meaning. It is not a question of law, but fair, reasonable construction. We are brought, therefore, face to face with the fact that, without these words, the patent would claim all it did at first; but, by adding these words, it qualifies the scope of the claims.

I quite admit, with your correspondents, that if by "equivalent plate" a non-inductive plate is intended, and the patent claims it, the patent is bad. If the United Telephone Company ever attempt to put this construction upon the words, they are at once upon the horns of a dilemma. Whoever their opponent may be, he may urge the alternative either that the patent is bad, or that he has not infringed. The patent does not once mention a non-inductive plate, or how such a plate could possibly be used. The reply to this objection could only be that, seeing how the membrane is used, it is obvious how the non-inductive plate could be used. Yes, but stay; if it is obvious without the patent telling us, how can the patent claim it? Where is the ingenuity in the application? We know that under the patent law the mere substitution of one well-known material for another cannot be protected, unless it has some additional property, in the application of which the apparatus has been made more simple in its construction. If, therefore, the patent claims what it does not describe, or even once mention (but yet is obvious from what we knew before the patent was granted), then the patent is bad. If it does not claim it, then a non-inductive plate with a bar armature is not an infringement.

The ordinary plea of "colourable imitation" (considering *all* the previous publications) does not apply, or is so limited as to have no practical value. A wood plate tympan attached to a bar armature would be a colourable imitation of the membrane and bar armature, but not a colourable imitation of the steel plates.

With regard to the opinion of Mr. Moulton on behalf of his clients, I am rather surprised at Major Barney putting this forward as being of any weight, seeing that this same Mr. Moulton has given his opinion, first, that a diaphragm and Hughes microphone transmitter (the Gower-Bell) is not an infringement of the Edison patent; and then, since the owners of the Edison patent have retained him, given his opinion, according to Major Barney, that a transmitter *without a diaphragm was an infringement* of Edison's patent. I have not the shadow of a doubt but that if next week some one managed to utilise a wheelbarrow for a telephone receiver, he would discover it was an infringement of his client's patent.

With regard to "Common Sense" and the Hughes microphone. He asks me to "give him a description of the Hughes microphone without a diaphragm which will transmit articulate speech," and he has previously said that a resonant case and the Hughes microphone was an infringement of the Edison patent. Now his own letter supplies the first information, and his admissions in that letter contradict the second. In his first letter he mentioned that he had seen transmitters, without the semblance of a diaphragm, that would transmit articulate speech. He now says in reply to my question as to their construction that they were made of wood and carbon—"a novel form of Hughes microphone without the semblance of a diaphragm or tympan," and he has previously told us it would transmit articulate speech. Here then is the very information he asks me to give him. What more does he want? As to the other point, if it is made of wood and carbon, whatever may be its outward construction, it is a resonant case and tension regulator. By *resonant* case one does not necessarily mean a thin wood box on the top or under the top or surface of which a tension regulator is fixed. Take Edison's patent (the very resonant box or tube which he disclaims), and fix in this box in any suitable manner the carbon pencils of Hughes. Abandon the tympan or diaphragm entirely, and if that is an infringement of Edison's patent my knowledge of the meaning of words is grossly at fault. In that case there would not be the semblance of a diaphragm or tympan to separate the sound waves from the tension regulator. There would be no partition or separator—no "something which separates something from something else"—no separator to mechanically communicate the force of the sound waves to the tension regulator. Everything vibrates more or less with the impacts of air—even a stone wall. But for the United Telephone Company to pretend that they have the right to carbon by whatever means it may be made to regulate the current is to assume that all Englishmen are fools. Their patent does not claim it, and what the patent does not claim it does not cover. Edison says—"the first especial feature that requires separate consideration is the peculiarity of the resonant tube for the voice." Further—"by providing an edge in the resonant tube below the mouth, upon which such consonant sounds are received, the vibrations are given either to the resonant tube or deflected to the diaphragm." He also says that it is advantageous to have "a vibrating edge placed in the lower part of the mouth-piece." It was necessary, therefore, for his resonant tube or case to have the property of vibrating (in addition to his vibrating diaphragm), and yet, knowing this property of its vibrating, he has disclaimed it, and says that he claims no part but the combination of the diaphragm and tension regulator. We cannot help it if the Edison Telephone Company made a gross blunder in not claiming the combination of the resonant tube and tension regulator. It is a *fact*, and Mr. Moulton cannot turn established facts so easily as he appears to change his legal opinions.

With regard to the inquiries of "S" my replies are:—

1. No! if not used in combination with a plate tympan of inductive substance. As I have told him before, a permanent magnet is the electrical equivalent of an electro-magnet, but if that does not satisfy him he will find a permanent magnet is described in the claims of Bell's American patent, and which, as Major Barney has pointed out, appears in the United States Official Gazette, received and open for public inspection in the library of the British Patent Office in July, 1876.

2. No! if not used in combination with the plate tympan of inductive substance.

3. This contains two questions. My reply to both is yes. Whether the battery is in the local circuit or the line circuit the magnetism in the magnet is only a question of degree. "S" should understand that there is nothing new in magnets being charged by a local battery, or in the use of a permanent magnet, but in the application of these old parts for a new combination for transmitting or receiving "vocal or other sounds" is where the patent right exists. It is the drumhead of inductive material in combination with the magnet, and the form of the magnet has nothing to do with it at all.

4. Yes.

F. T. H.

Derby, *December 22nd*, 1884.

An Undulatory Current in a Closed Circuit not necessary for Telephonic Transmission.

I send you a brief statement of the results of experiments, of which I have frequently spoken to you, which established the fact that for the perfect transmission of articulate speech by means of any good transmitter and receiver, it is not necessary to have a closed circuit, and, as a consequence, the perfect transmission of articulate speech is practicable when the current traversing the transmitter is an intermittent current; that is, a current not continuous but broken at regular intervals.

I am well aware that this statement is in direct opposition to the opinions expressed by many eminent electricians, who, in my humble opinion, having blindly accepted Mr. Bell's theory of the principle of the working of his reputed invention, stick to their first opinions, and persist in supporting by their expert evidence the theory of Bell, and assert that the undulatory current in a closed circuit is absolutely necessary for the transmission of articulate speech by means of the telephone. There are other equally scientific persons who believe and assert the contrary.

In making my experiments I used instruments made for me by Breguet, of Paris, for the purpose of rapid telegraphy by means of the well-known Bain chemical system, and by means of said instruments, one thousand words in Morse characters were transmitted from Ostend to Belgium, and the despatch was perfectly legible.

I connected up a Boult (De Kraft) transmitter and receiver, using three medium-size Leclanché cells connected to the carbon microphone through the automatic transmitter, in which I used a ribbon of paper having a line of small holes very close together, running longitudinally through the centre, similar to the paper used by the Wheatstone instrument. The automatic transmitter was then put in motion, and the paper was passed over the metallic drum beneath the wire brush which made the contacts through the holes in the paper and allowed the current to pass on through the microphone at a speed of about 1,000 words in one minute. While this paper was passing, and the continuity of the current was continually broken, words spoken directly to the carbon microphone without the intermediary of a diaphragm, and without any substance whatever below the carbons, were distinctly heard from the receiver, and the articulation was as perfect as when the current was continuous. Against the theory of Bell and others I submit these *facts*, which any one can very easily verify by employing similar means.

I should have been pleased to invite you and all others interested to witness a repetition of the experiments, had I not sent the instruments to New York to be used to demonstrate that the closed circuit, with what Bell erroneously called an undulatory current, is not necessary for the transmission of articulate speech by means of electricity.

W. C. Barney.

December 29th, 1884.

[Perhaps some of our readers may have opportunities of making further experiments in the direction indicated by Mr. Barney.—EDS. ELEC. REV.]

Fluorescence or Phosphorescence.

It is well known that fluorescence or phosphorescence is common to a great many substances, such as certain varieties of fluor spar, glass coloured by peroxide of uranium, red seaweed, also when a lump of sugar is broken, &c., but the cause of this phenomenon is still a matter of doubt to many. It is believed by Professor Stokes that the explanation of fluorescence lies in the communication of motion by means of the intermolecular forces from the molecules or parts of a molecule thrown into agitation by the vibrating ether to the neighbouring parts, and thence to the mass in general.

The following experiment appears to agree with the above explanation of Professor Stokes.

By holding a partially-exhausted incandescent lamp in one hand, and rubbing it with the other until it becomes warm, beautiful fluorescent effects may be produced. Of course these effects are best seen if the experiment be performed in a dark room. After being rubbed, if the lamp be tapped by the finger, fluorescent effects almost as bright as in the former case will be produced. The heat thus produced by rubbing and the vibration by tapping, appear to be the causes of fluoresence in this case. If the vacuum be either *very* good or *very* bad, these effects will be produced with difficulty; if the vacuum be entirely destroyed, no effects will be observable.

We may conclude from the foregoing that the vacuum of incandescent lamps may be roughly tested in this manner, and that there is a degree of vacuum at which the fluorescent effects will be maximum.

Again, if the partially-exhausted bulb, after having been rubbed and allowed to cool to its normal state, be again tapped, fluorescent effects will be produced as before, showing that it is possible to *store* light in a degraded form, and probably not reducible to incandescence.

Since these effects take place in a vacuum they are to a certain extent independent of temperature or chemical affinity, and are, I think, directly due to mechanical action.

John B. Duncan.

16, Brandling Place, Newcastle-on-Tyne,
27th December, 1884.

Heating by Electricity.

Public mention has been lately made of experiments carried on in France for heating railway carriages with electricity. Heating by electricity has not as yet attracted the attention which so important a subject would seem to merit, and it may therefore interest your readers to know that since October, 1883, I have successfully warmed some of the smaller rooms of my house with a very simple apparatus, as described in my patent, "Electrical heating," No. 4961, 1883 (some of the forms of which are specially designed for railway carriage warming). In heating rooms by this means there is the great additional advantage that a current of fresh air from the exterior can be passed through the electrical heater so as to enter the room at any desired temperature, within moderate limits; the outside air being, say, at freezing point, can enter the room fresh and pure at a temperature of 200°, causing thorough ventilation, a matter of no small importance for sick rooms or hospitals. A modified form is used nightly in my house as a bed warmer, the heat being turned on or off at the bedside at any required moment, a great convenience for invalids. As a minor use I also employ the same principle for a chicken incubator, and it is especially applicable to the French system of "thermostatic" nursing, avoiding the noxious fumes of gas or oil at present employed.

An ordinary foot warmer for railway carriages is a very simple adaptation of the same principle; but if desired, fresh warmed air can be admitted, and the temperature of any closed carriage be regulated by the form used for chamber heating. When once the electric current is furnished to railway carriages for lighting purposes, which cannot be long delayed, this will doubtless prove to be a very convenient and cheap method for heating them. If the arrangement is fitted to permanent receptacles containing salts, such as acetate of soda, the heating of carriages can be carried out with still greater facility and convenience, and at a very low cost.

With the further exception of the system patented by Mr. Oswald Rose in May, 1882, I have no knowledge of any other attempts to deal practically with the subject.

J. S. Sellon.

Fires from Belting.

In your issue of ELECTRICAL REVIEW of 27th inst., there is a note on fires from belting, and credit is given to Herr Boher, of Dresden, for his experiments. The subject is no novelty to English engineers and manufacturers; and it is perfectly well known that not only flour mill fires may be so caused, but many others. There is no doubt that in American cloth works, where varnish and lamp-black are freely used, that many conflagrations have arisen from this cause, and I have seen conductors erected near the belts to prevent evil consequences. I have myself frequently taken off electricity from running belts with one hand, and have lit gas jets with the forefinger of the other hand. Anyone may do this from almost every belt in any shop where the belt is crossed or subject to friction. If anyone will put his hand within four inches of a crossed belt, or even a belt not crossed, running a dynamo machine at high speed, he will feel a pricking sensation in his fingers from the electricity generated by the belting. I speak of ordinary leather belting; I do not know what effect link belting produces.

S. J. Mackie.

London, *29th December*, 1884.

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